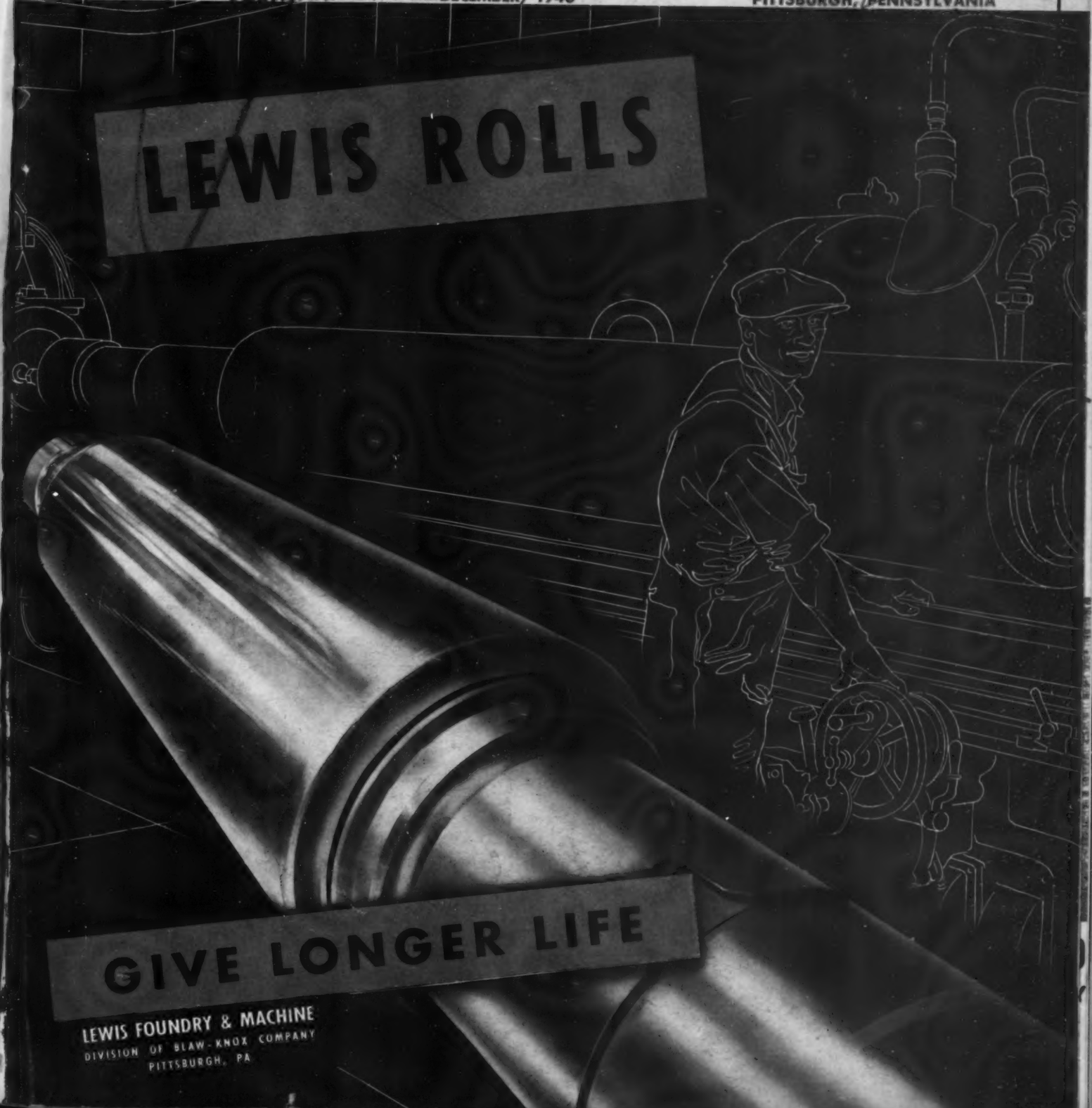
Iron and Steel ENGINEER

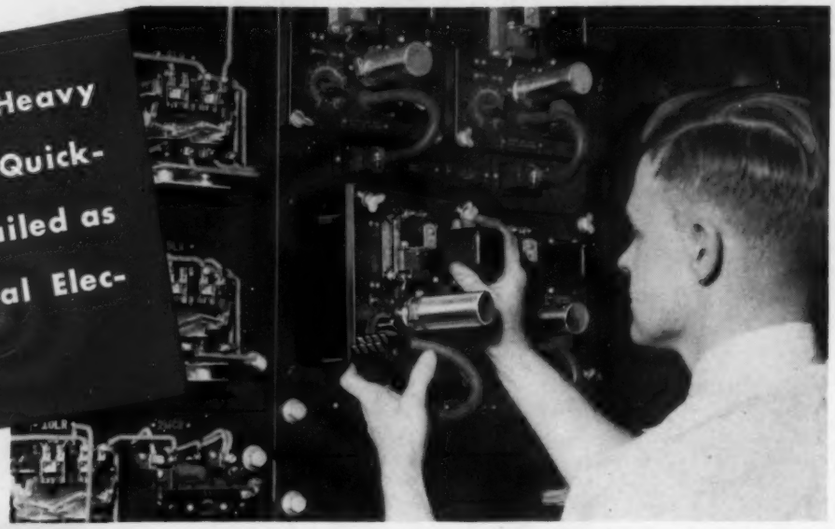
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

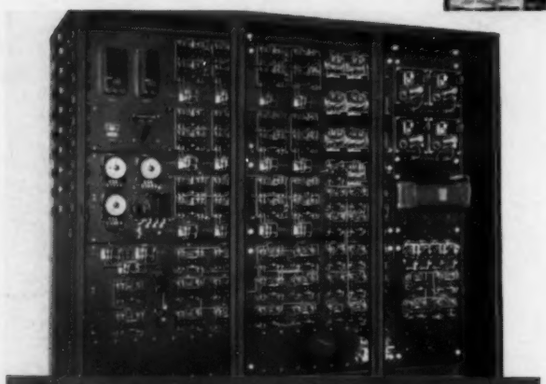
1010 EMPIRE BUILDING, TECHNOLOGY DEPT. DECEMBER, 1946 PITTSBURGH, PENNSYLVANIA



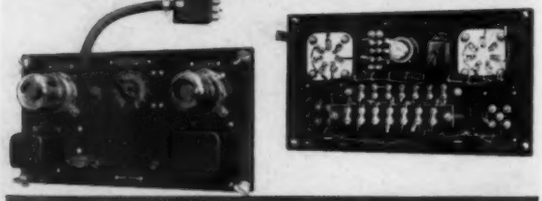
Now . . . *Electronics to Mill Standards*

New Cutler-Hammer Heavy Duty Construction and Quick-Change Unit Panel Hailed as Outstanding Industrial Electronics Contribution.

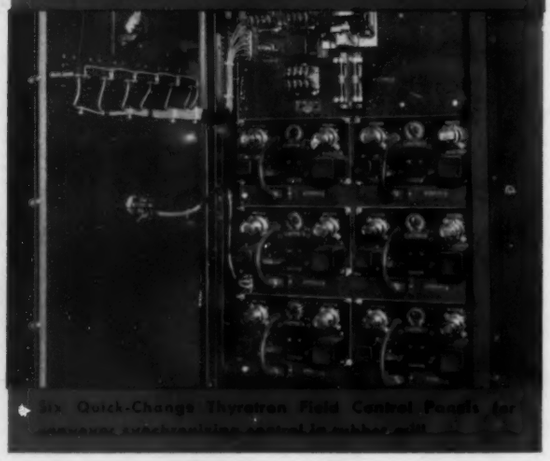




C-H Supervisory Electronic Quick-Change Units on Enameling Furnace Control Panel. Here C-H Magnetic and Electronic Control is engineered to achieve the full practical advantages of both.



Over-and-under or Quick-Change Unit Panels have simplicity, ruggedness, wiring, spacing. Also screw terminals, wing nut mounting, plug-in connector.



Six Quick-Change Thyratron Field Control Panels for accurate synchronizing control in rubber mill.

To the public, industrial electronics is a miracle maker. To many a mill's electrical department its practical application now becomes a reality.

Equipment has been fragile and complex . . . tough to install and remove, to test and inspect.

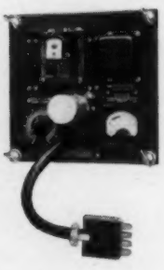
The Cutler-Hammer answer to mill duty electronics is a development now almost four years old, hailed by leading industrials as an outstanding contribution to practical electronics.

First of all, Cutler-Hammer engineers took electronic control equipment out of the radio receiver class and built it up to heavy duty industrial standards. Components are simple and rugged, minimum in number, better spaced, better wired and designed expressly for easy renewal of parts.

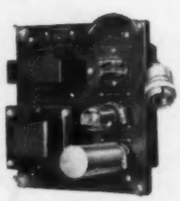
The introduction of the C-H Quick-Change Unit Panel now safeguards continuous mill operation plus other important advantages. Components are now mounted as a unit on a removable panel, assembled to the control board by means of captive wing nuts with plug-in connector. Inspection and instrument testing, back at the service bench is convenient because removing one electronic control panel and substituting a "spare" in its place is the matter of a moment.

These sane and sound solutions are another product of Cutler-Hammer's "electronics-in-industry" experience dating back to 1916. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate*: Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
ELECTRONICS
C-H



(at left) Typical C-H Mill Type Quick-Change Unit Panel for Furnace Control.



(at right) C-H Quick-Change Unit Panel for photo-electric limit switch used on automatic tube cut-off machine.

AETNA-STANDARD

Milestone News About CONTINUOUS STRIP GALVANIZING

The steel industry passes an important technological milestone. Another production dream has come true.

Two of America's best-known mills are building the first high production continuous lines for hot dip galvanizing steel in coils . . . wide widths, light and heavy gauges.

Both companies have been experimenting for many years in search for the answer. Each has arrived at certain exclusive features which have been protected by patents.

Aetna-Standard has been called in to do the designing, engineering and mechanical work on both lines. Aetna-Standard feels proud that these mills have the confidence to hand over exclusive and confidential data about this important milestone in the steel industry.

Breathing production life into ideas is our business.

Here's a schematic drawing of a continuous terne line. Aetna-Standard pioneered in the development of this equipment for wide coils.

★ Since the early days of the cooling wheel, Aetna-Standard has introduced many new ideas in coating equipment. We were the first to commercially produce a continuous line for drying, the originators of the completely synchronized roll drive; straight line galvanizing, high speed sheet galvanizing and now continuous strip galvanizing.

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES:

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND

JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

DELTABESTON*

Beats 'em All!

If there's a hot spot in your plant that threatens the power supply, Deltabeston can help you play safe. The unusual conditions met in steam tunnels, boiler rooms, steel plants, central stations . . . at furnaces, ladles, and soaking pits are tough on ordinary wire and cable. General Electric builds its Deltabeston cable to meet — and beat — these hazards.

There's a Deltabeston cable to protect against high ambient temperatures, another to take sudden temperature rises, many combinations in design and construction to maintain the safety factor you want. Or you may need a special cable, like the one illustrated, to meet an unusual set of conditions. This is one of many cables developed by General Electric engineers who are specialists in this field. They are ready to help in solving your wire and cable problems.

**Trade-mark Reg. U. S. Pat. Off.*

For a copy of the complete Deltabeston catalog, write Section Y15-1231, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut. Deltabeston Wires and Cables are distributed by G-E Merchandise Distributors.

GENERAL ELECTRIC

HYDRAULIC DEEP DRAWING

WITH AN AUTOMATIC ALL OIL-HYDRAULIC DOUBLE ACTION PRESS

250/90 TON SELF-CONTAINED OIL-HYDRAULIC DOUBLE ACTION DEEP DRAWING PRESS

SUPPLIED TO THE ALUMINUM COMPANY OF CANADA LTD.

EASILY ADAPTABLE TO SINGLE ACTION OPERATION

FOR DEEP DRAWING

OF VESSELS WITH DIFFERENT DEPTHS AND SHAPES

OF LIGHT METALS AND STAINLESS STEEL

WITH HIGHEST ADJUSTABILITY OF SPEED AND PRESSURE EASILY ACCESSIBLE QUICK SETTING OF DIES

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BY MEANS OF LIMIT SWITCHES

AUTOMATIC PRESSURE REVERSAL
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FOUR-CORNER-INDEPENDENT PRESSURE ADJUSTMENT OF BLANK HOLDER
FOR DRAWING VESSELS OF UNEVEN CONTOUR

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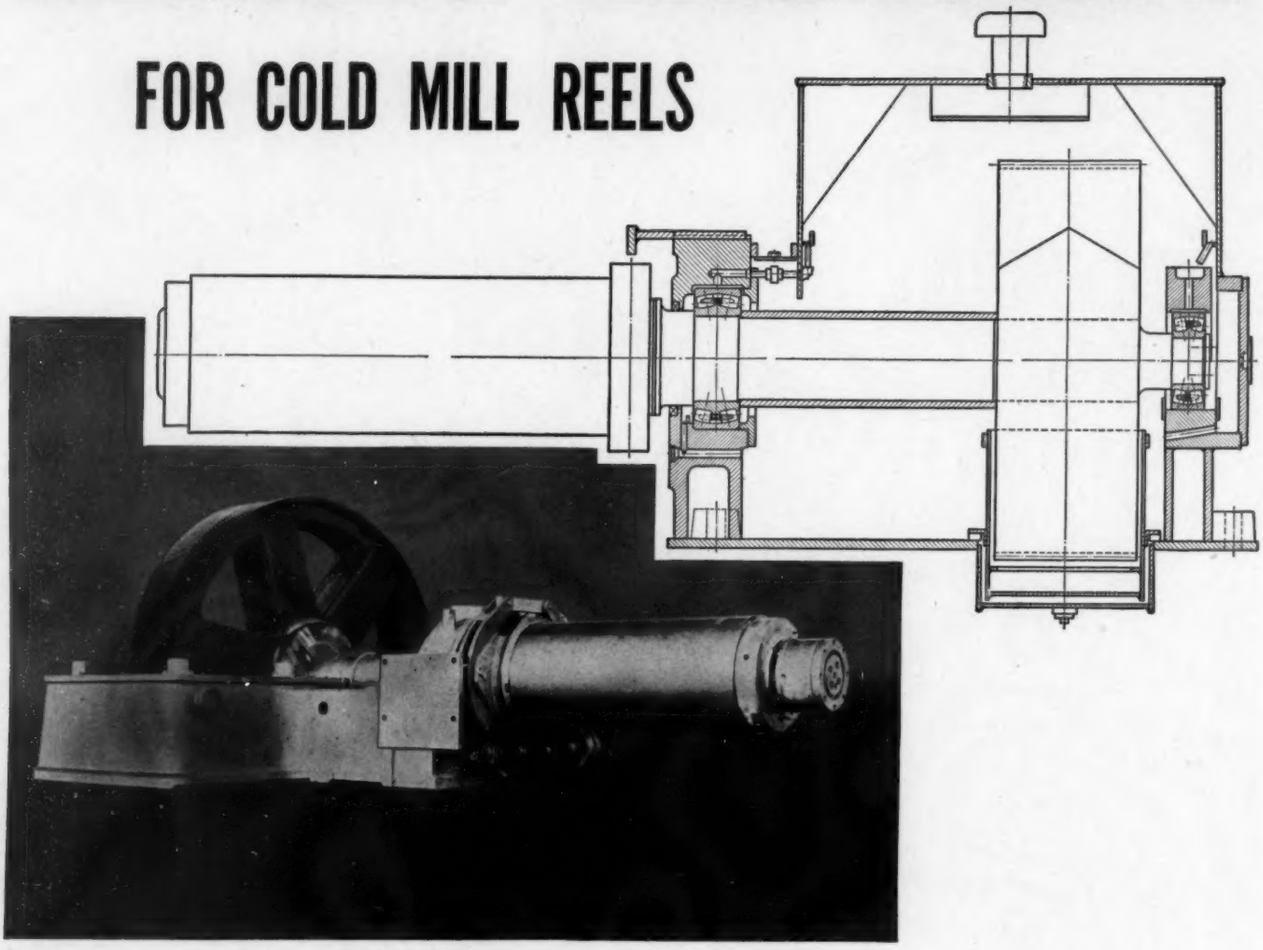
ROLLING ALIGNMENT

FOR COLD MILL REELS



Despite deflection, misalignment and enormous loads imposed on overhung reels, the *rolling alignment* of SKF Spherical Roller Bearings assures full capacity for useful work. No adjustments are required, and only infrequent lubrication is needed. Another outstanding example of what SKF—the pioneer of self-aligning bearings—means to the Steel Industry. 6174

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

SKF
BALL AND ROLLER
BEARINGS

UNITED

HEAVY DUTY ROLL LATHES

Headstock Faceplate Directly Driven by "Cone Worm" Gears

Advantages

1. Operation at a Steady, Uniform Speed—"CHATTERLESS"
2. Cone Worm Drive Permits Compact Construction
3. Low Head Room—Facilitates Entry of Roll
4. Motors Protected by Headstock
5. Cone Worm Drive Rated Conservatively

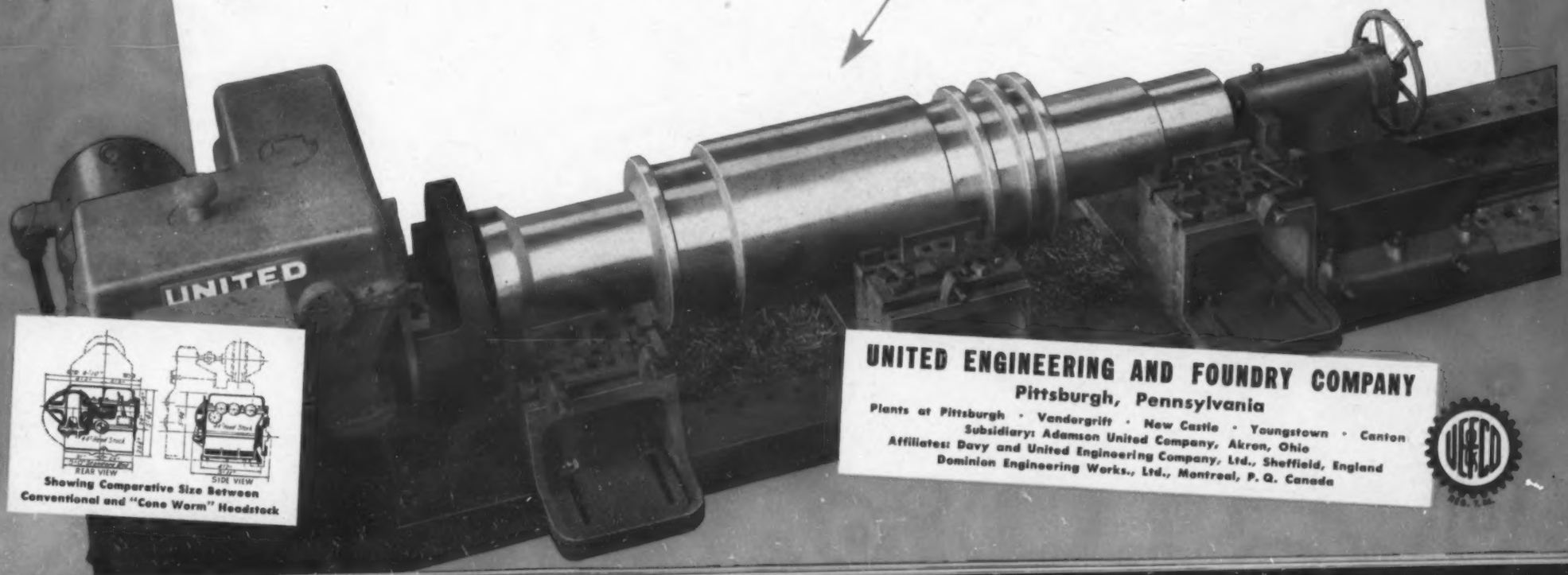
The "Cone" type of worm gearing used in UNITED HEAVY-DUTY ROLL LATHES, with its hour-glass shape of worm partially "wrapping" the gear and thus bringing more teeth in constant contact, provides maximum capacity in the smallest space, and chatterless operation. This superiority has been definitely established by test and experience in UNITED 4-high mill screwdown applications.

Low head room facilitates crane handling of rolls, and compact construction permits more floor space and visibility between lathes.

All gearing up to the main cone worm faceplate drive is either single or double helical, is fully roller bearing mounted and carefully proportioned with reference to both velocity and load requirements. These fully enclosed gears and bearings are lubricated by forced oil circulation.

UNITED HEAVY-DUTY ROLL LATHES can be furnished for either "fixed" or "rotating" center.

Consult UNITED engineers for full technical data.



Showing Comparative Size Between Conventional and "Cone Worm" Headstock

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

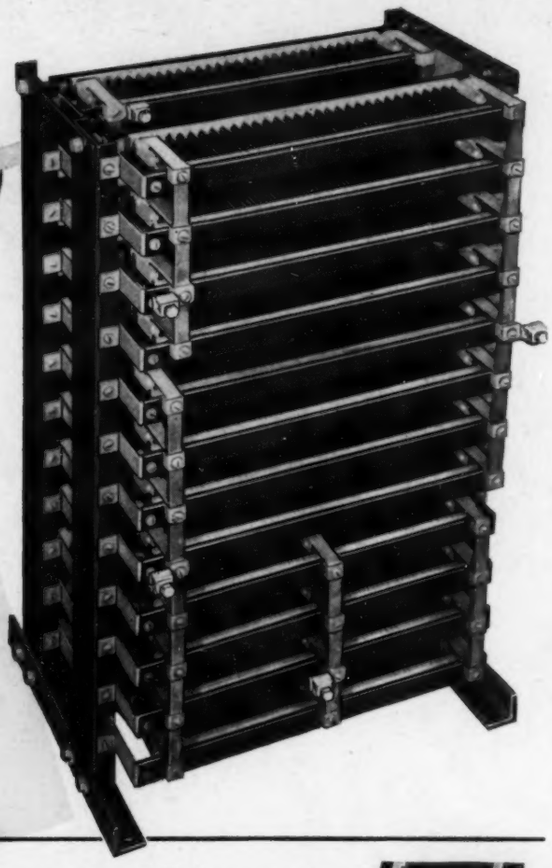
Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

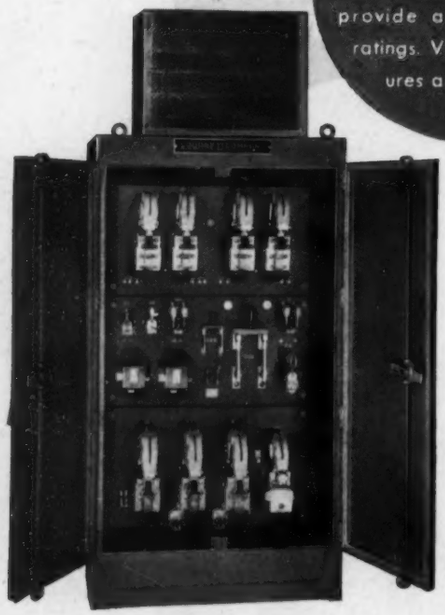
Dominion Engineering Works., Ltd., Montreal, P. Q. Canada

adjustable EDGEREST RESISTORS

for Mill Duty applications where uninterrupted production is vital and service is severe

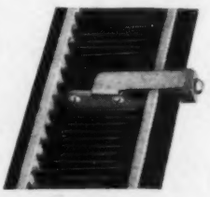


Edgerest resistor banks are constructed from units of various lengths, gauges of ribbon, and kinds of metal to provide a wide range of ratings. Ventilated enclosures are available.



Mill Type Control with Ventilated Resistor

Only one style of terminal clamp used for all connectors . . . supported by porcelain blocks to avoid strain on the ribbon . . . easily placed in any position, permitting close adjustment of resistance values.



NON-BREAKABLE • unaffected by vibration.

CORROSION-RESISTANT • stainless steel and nichrome ribbon.

EDGEREST DESIGN • ribbon bent on flat to avoid reduction in cross-section, eliminate stress and provide rigid support in mounting.

TERMINALS • clamp type, supported at both sides of frame to eliminate strain on ribbon.

ADJUSTABLE • terminal clamps can be placed on any loop of ribbon, permitting close adjustment to suit actual operating conditions.

EFFICIENT • ribbon suspended with no obstruction to retard air flow. Stacks provide chimney effect. Minimum radiation to metal supports.

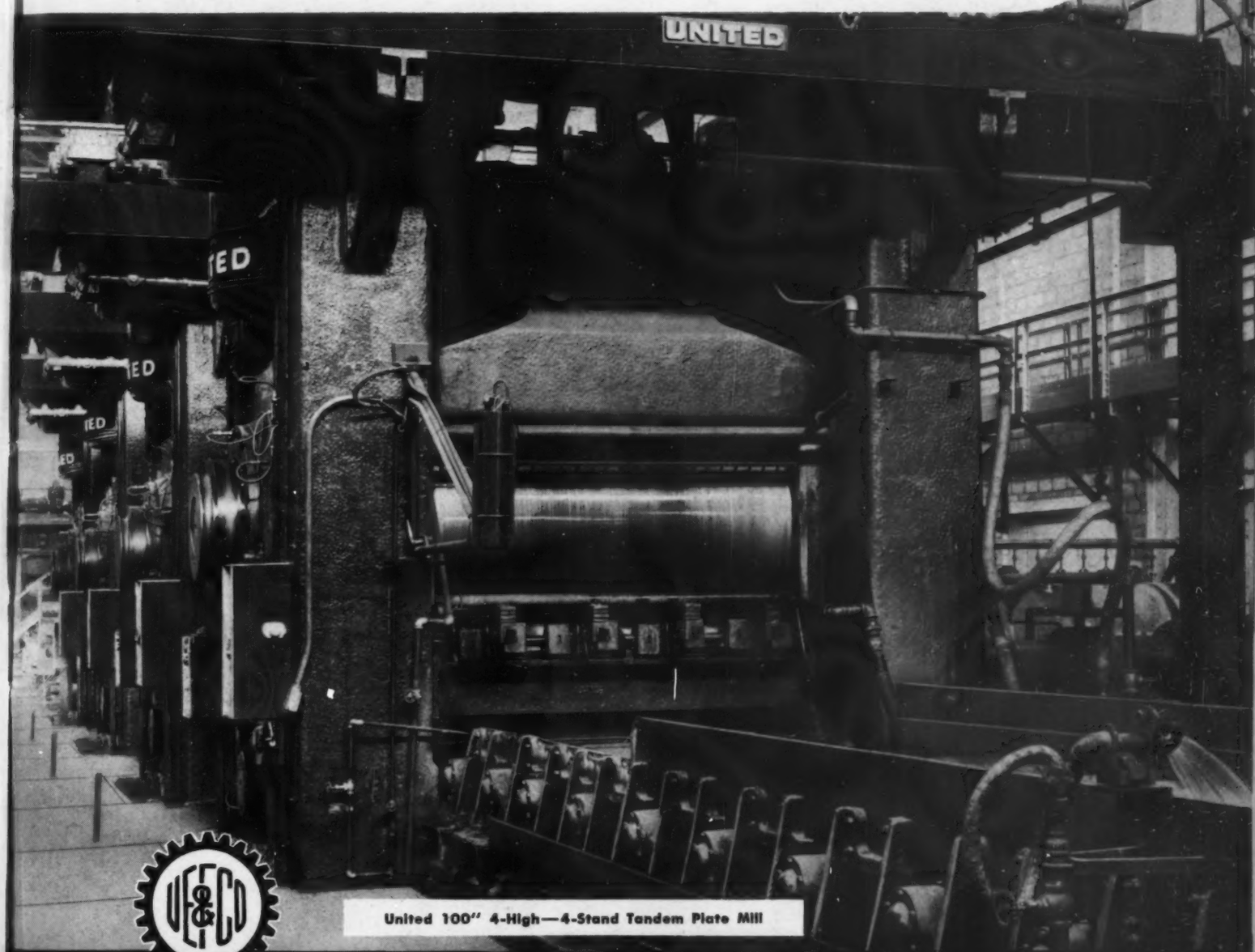
MOUNTING • individual units are removable from frame without disassembly.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

UNITED

Pioneer Designers and Manufacturers of Outstanding Rolling Mills



United 100" 4-High—4-Stand Tandem Plate Mill

UNITED ENGINEERING and FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Pa.; Vandergrift, Pa.; New Castle, Pa.; Youngstown, Ohio; Canton, Ohio

Subsidiary: Aluminum United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q., Canada

STEEL
1946
NEWS OF INDUSTRY
New Factors Complicate Scrap Supply Problem
New York
• • • Factors that last week gave some scrap market observers reason to feel that the worst had passed have since been overshadowed by subsequent developments. Overall gains in industrial output, indications that July employment had hit a new 60 million
definite improvement
SCRAP
Scrap Shortage Threatens Sharp Steelmaking Cut
Some production already being lost as supplies are withheld from market. Receipts only 35 per cent of needs
SHARP reduction in steel mill operations within the next few weeks as result of a serious reduction in the movement of scrap to mills is expected by steel producers.
Already some steel production is being lost because of the acute shortage
Ships damaged in the war or declared overage or surplus are providing some scrap for steel mills. Above are shown parts of a wrecked aircraft carrier in the Bethlehem, Pa., yard of Bethlehem Steel Co.
Scrap Shortage Chief Obstacle to Steel's Recovery
Request for higher price ceilings refused by OPA. Mills have less than half normal inventories. Resumption of adequate flow must await higher operations in metalworking plants. Ingot production recover
to 75 per cent
SHORTAGE of
now constitutes
the steel in

BILLETEER-equipped mills suffer less from scrap shortages

Scrap shortages work less hardship on mills which condition steel the Billeteer way.

Instead of "burning up" valuable scrap, Bonnot Billeteers thriftily save every ounce of steel removed from billets . . . classified according to analysis . . . ready for the charging box. No other cleaning method permits salvage of scrap.

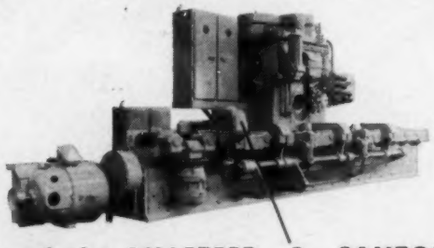
One mill, operating four Billeteers, saves over six tons of scrap a day, more than 2000 tons a year. What's more, it is often able to salvage billets so badly seamed that hand-chipping or flame-conditioning would be impractical.

In addition, it enjoys other important advantages

FOR INSTANCE: One man with a Billeteer does the work of ten manual chippers . . . does it neater and better . . . releases men for less-killing, more-profitable work.

The Billeteer never tires . . . never gets groggy . . . never has off days. Operations go along on an even keel.

Learn how the Billeteer can ease future scrap shortages for you while helping to cut your other billetshed costs. **Write.**



Engineered

FOR LOWER OPERATING COSTS

BONNOT

THE BONNOT COMPANY • builders of the BILLETEER • CANTON 2, OHIO

• Bonnot Billet Inspection Tables • Charging Tables • Cold Saws Grinding Pans • Clay Mixers • Clay Feeders, Etc. •

TIMKEN BEARING EQUIPPED

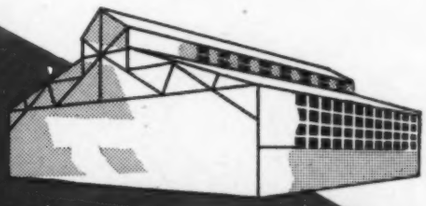
ROLLING TECHNIQUE . . .

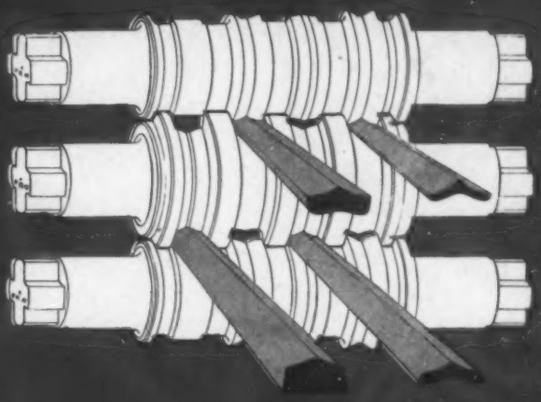
Angles

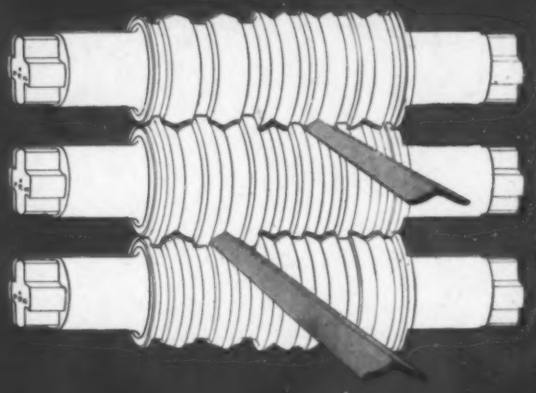
Angles, of both the equal and unequal types, are probably the most commonly rolled shapes. Equal angles from ¾″ x ¾″ to 8″ x 8″ and unequal angles from 1″ x ¾″ to 10″ x 4″, cover a wide range of sizes having hundreds of uses. Numerous sizes of these angles are rolled of non-ferrous material as well as steel.

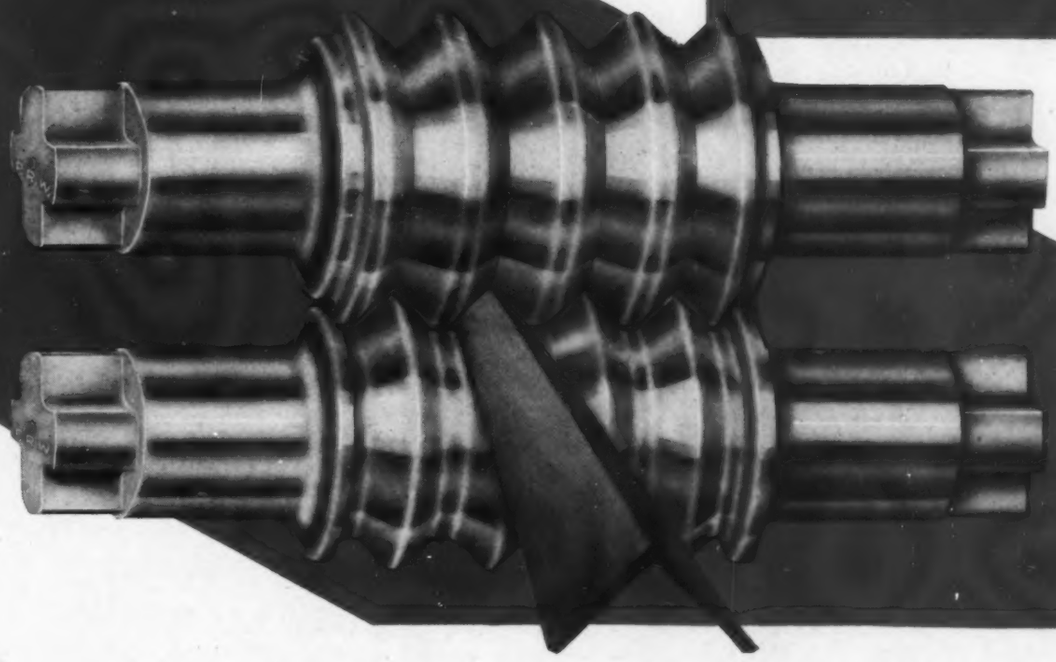
Pittsburgh Rolls with over three-quarters of a century of roll-making experience and satisfactory performance behind them, can be relied upon to deliver production of highest quality for which high speed modern mills are designed, at *less cost per ton of steel rolled.*

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.

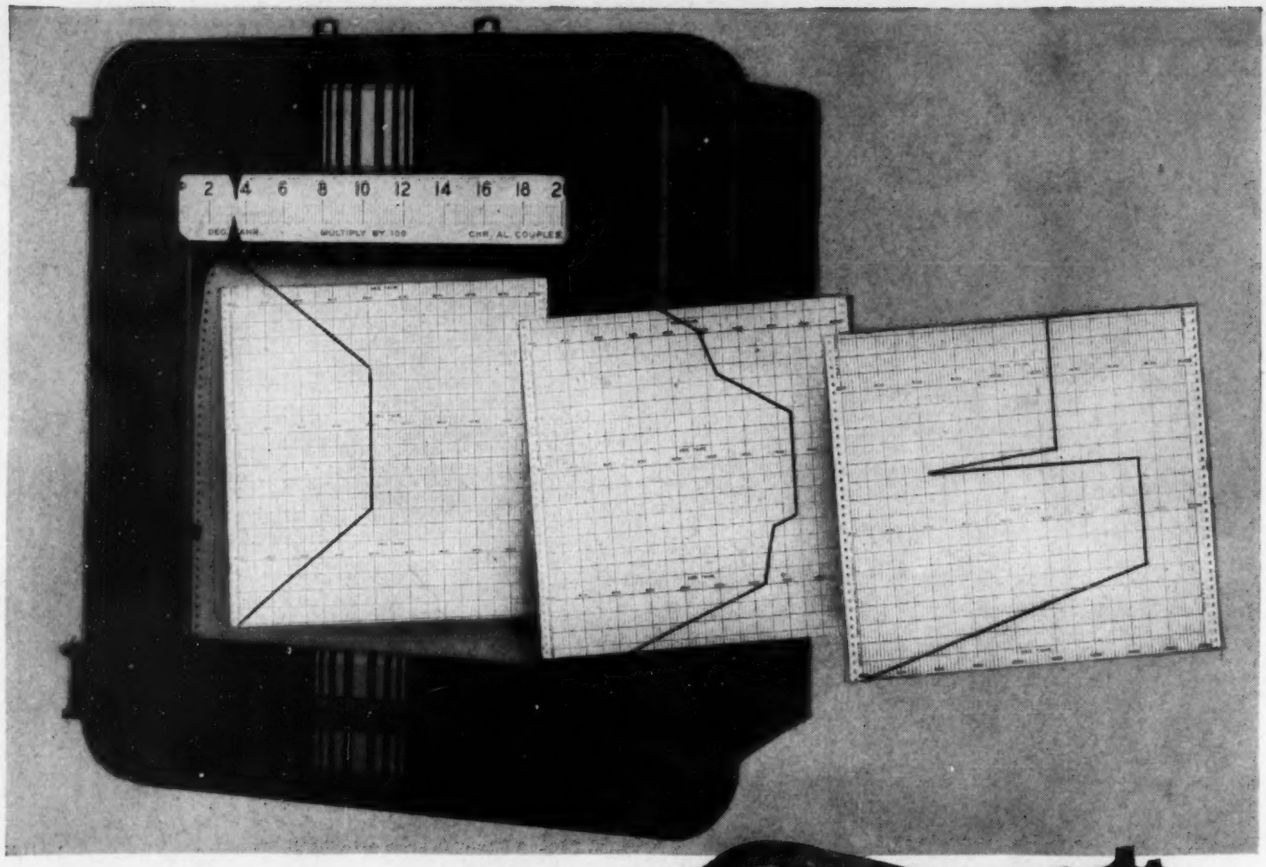








PITTSBURGH ROLLS



Micromax Program Controller, with typical malleableizing cycles shown schematically. At right is a truck axle housing made by Eastern Malleable Iron Company and malleableized under Micromax Program Control.

PROGRAM CONTROL

Increases the Efficiency of Men and Machines

Automatic control of a furnace's entire temperature program — heating and cooling as well as soaking — is now helping to improve the quality of production in many plants. Micromax Program Control "steadies" the heating and cooling rates, exactly as automatic control holds any other temperature steadier than manual control. Micromax users say that the resulting improvement of product quality is more or less automatic.

In addition to improving quality, Micromax ends the last (and largest) amount of manual valve operation. Fuel valves need far more attention during heating and cooling than during the soak, and most users say that Micromax Program Control actually saves far more routine valve adjustment than was saved by soak control alone.

There is a Micromax Program Control to meet practically any industrial need. Information on request.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

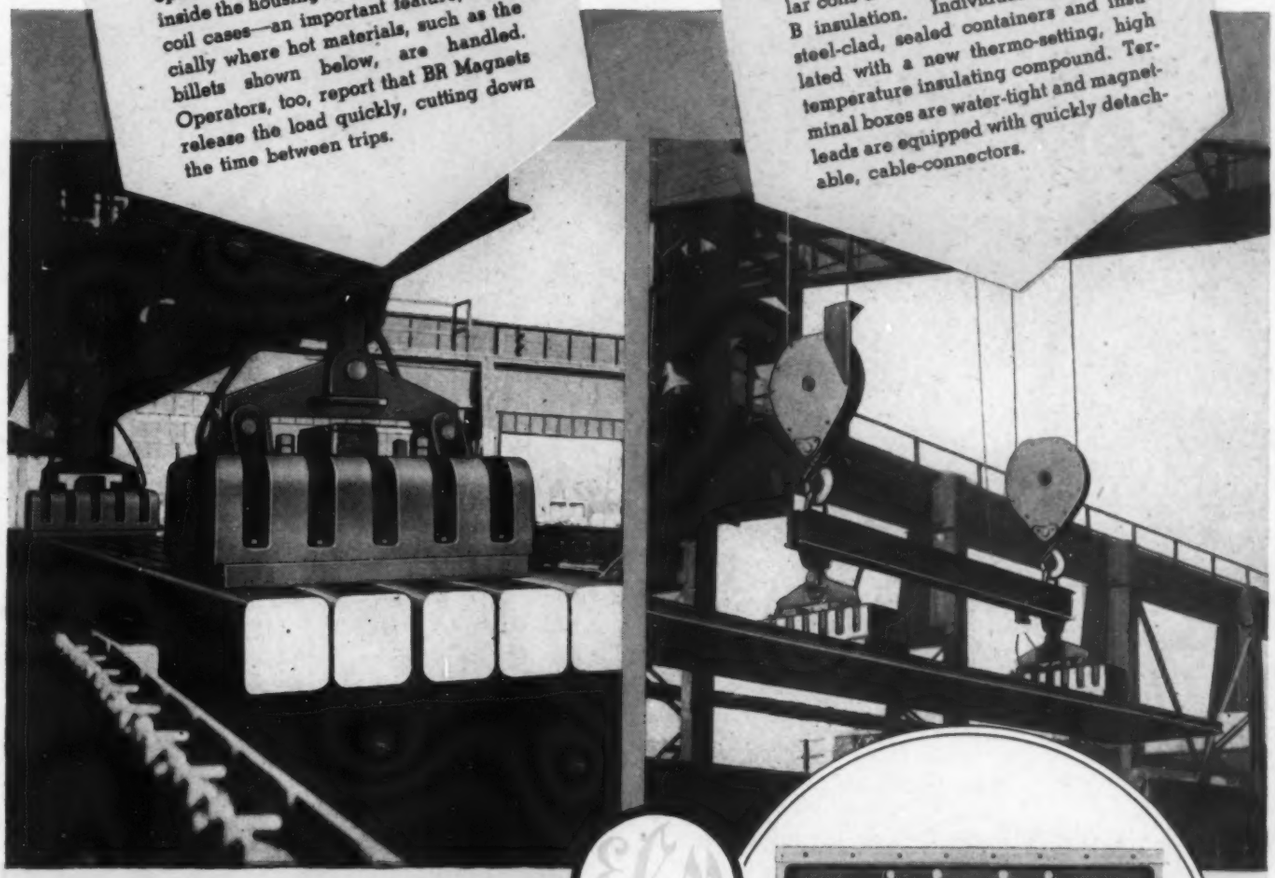
Jrl. Ad N-33A-666(1b)

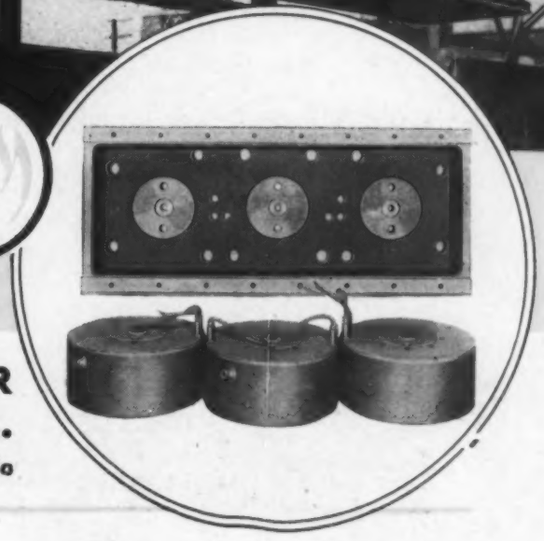
Improved BILLET and RAIL HANDLING with EC&M "BR" MAGNETS

These are heavy-duty magnets designed especially for handling rails, billets, bars, pipe, structural shapes, etc. Usually they are worked in pairs, being suspended by their suspension yoke from a spreader-bar and operated in parallel from one controller. For single magnet installation, chain suspension is standard.

Magnet-housings have ventilating openings in the top and both sides. These openings permit free circulation of air inside the housing around the individual coil cases—an important feature, especially where hot materials, such as the billets shown below, are handled. Operators, too, report that BR Magnets release the load quickly, cutting down the time between trips.

The design of these Type BR Magnets departs radically from the conventional in that, instead of a single (or perhaps two) oblong coils, these BR Magnets are fitted with several tightly wound, circular coils of bare strap copper with Class B insulation. Individual coils are in steel-clad, sealed containers and insulated with a new thermo-setting, high temperature insulating compound. Terminal boxes are water-tight and magnet-leads are equipped with quickly detachable, cable-connectors.





Above: Pair of No. 2 Type BR Magnets with five billets for deposit into annealing box.

Upper Right: Pair of No. 3 Type BR Magnets lifting single layer of rails—also used for handling double locked layer of rails.

Lower Right: Pre-assembly view showing how circular coils are keyed and bolted to No. 3 BR Magnet Housing.

THE ELECTRIC CONTROLLER AND MANUFACTURING CO.

2698 East 79th Street **Cleveland 4, Ohio**

"I amazed our board when I showed them a 55% savings in material handling"
TURNS OVERHEAD INTO PROFITS
WE WANT LABOR TO SHARE THE BENEFITS

Let an A.T.C. Specialist do the same for you!

Yes, such savings are possible. An A.T.C. Specialist will show you the record—give you proof that Automatic Fork Trucks bring business real profits . . . the dollar profits that 55% material handling savings represent.

These brawny giants of electric power have so many money-saving, energy-saving applications in your plant. By unit load pallet and skid principle, they move materials into, through and out of your plant with easy efficiency—spare your workers gruelling work, make money for you where it formerly was costing you money.

No material or product is too cumbersome to lift, move or stack. You can store your products ceiling high. One man does it, where three or four men hand stack only half as high. You add storage space, release labor for more productive, pleasant work. Product damage is cut down, accidents lessened.

Give your business this chance to turn a fixed overhead into a fixed profit, while you lighten labor's load. Let an A.T.C. Material Handling Specialist survey your material handling. Mail the coupon.

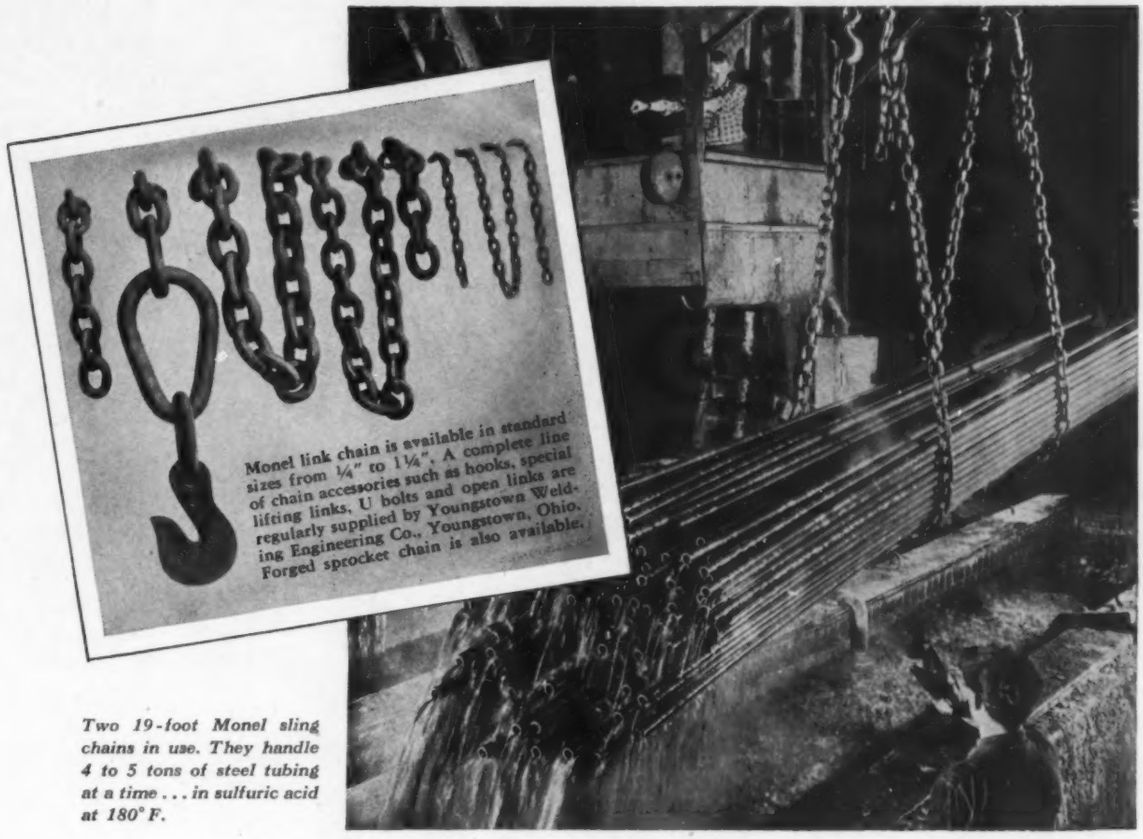
Automatic
ELECTRIC TRUCKS
Lighten LIFE'S LOADS

AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
47 West 87th St., Dept. X, Chicago 20, Ill.
Please mail me, without cost or obligation, complete facts about AUTOMATIC FORK TRUCKS.
( ) Have an A.T.C. Material Handling Specialist call.

Company Name.....
By.....*Position*.....
Street Address.....
City.....*State*.....

"For our **HEAVIEST** loads we use LIGHTWEIGHT chain!"

... says steel mill pickling superintendent


Monel link chain is available in standard sizes from ¼" to 1¼". A complete line of chain accessories such as hooks, special lifting links, U bolts and open links are regularly supplied by Youngstown Welding Engineering Co., Youngstown, Ohio. Forged sprocket chain is also available.

Two 19-foot Monel sling chains in use. They handle 4 to 5 tons of steel tubing at a time ... in sulfuric acid at 180° F.

Which would you consider safer ... ¾" chain that had already seen 6 years' service ... or 1¼" chain only 9 months old?

The newer, heavier chain, you say? Read what this user reports:

> *"... the 1¼" cast acid-resisting chain began to need repairs after nine months of service. So—in spite of the great difference in size—whenever we have particularly severe loads, we use the ¾" Monel chain. Although it is over six years old, we find it reliable and not subject to sudden breaks, as is the case with the cast acid-resisting chain."*

Monel* pickling chain is made from hot-rolled Monel rod, formed in specially designed dies. The links are welded. Made in this way it is much stronger and tougher than the cast acid-resisting type.

Even *more* important, Monel chain resists corrosion by pickling acids ... it *retains* its strength and thus provides years of trouble-free, economical service. The same is true of crates, baskets, tie-rods and other Monel pickling equipment.

MAKE CHAIN SELECTION EASY

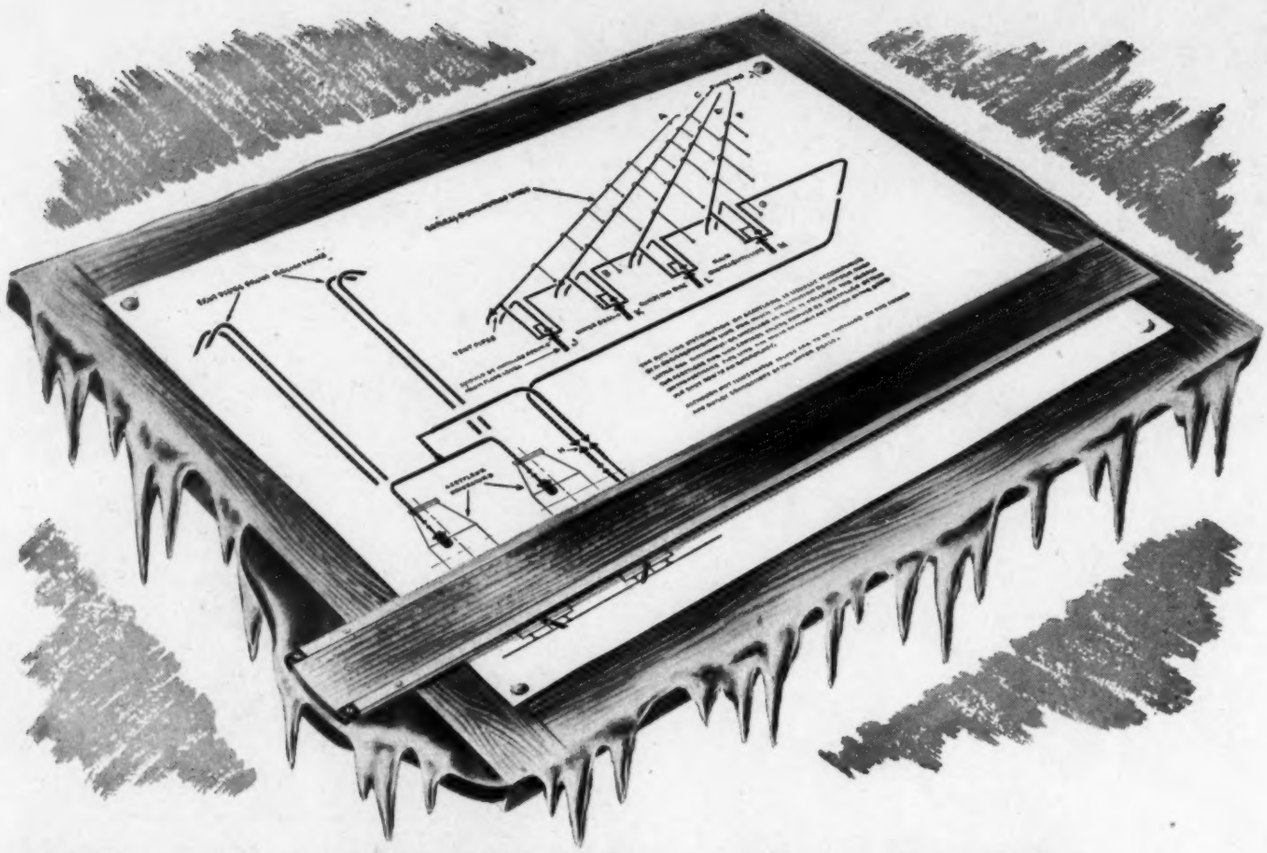
There's practical help in choosing the right chain for your pickling jobs in the illustrated folder, *Corrosion Resistant Chain.* It contains tables of link sizes and specifications for various loads, indicates number of links and weight per foot of chain, and shows recommended assemblies for single, double and multiple sling chain. Write for your copy ... now.

The International Nickel Company, Inc.

67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

Monel



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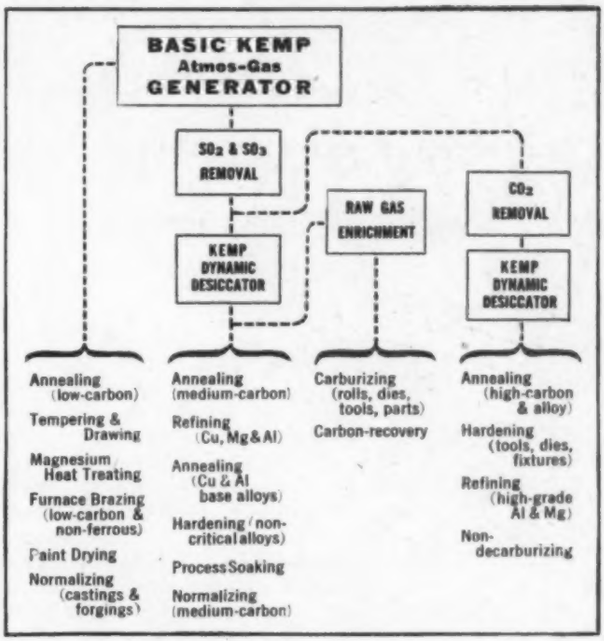

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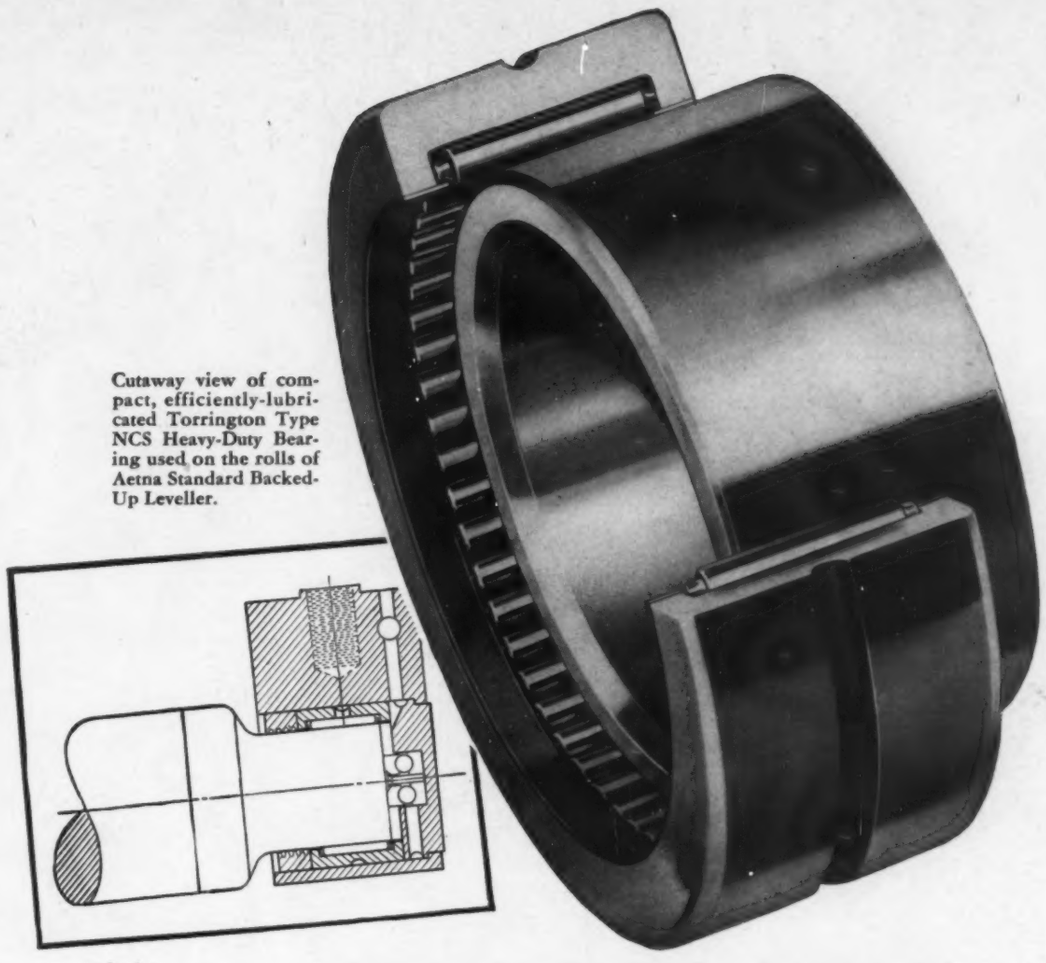

Cutaway view of compact, efficiently-lubricated Torrington Type NCS Heavy-Duty Bearing used on the rolls of Aetna Standard Backed-Up Leveller.

FOR COMPACTNESS AND MAXIMUM CAPACITY

Because they combine compactness and high capacity with ease of lubrication, Torrington Type NCS Heavy-Duty Needle Bearings are first choice of designers for such equipment as roll levellers for straightening and restoring ductility to sheet metal. A typical Backed-Up Leveller has 57 rolls that turn on 114 of these light, sturdy bearings.

In addition to standard Type NCS Needle Bearings, Torrington's Bantam Bearings Division designs and builds large, heavy-duty bearings for roll necks, screw downs, edgers, shears, pinion stands, strip reels and other steel mill equipment. Our engineers invite consultation on any anti-friction problem, routine or unusual.

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This latest addition to the Torrington line is a self-aligning bearing, specifically adaptable for heavy-duty performance. Sizes will be available to cover a complete range from 1.5748" bore and up. Write for Bulletin 200 or see your nearest Torrington Representative.

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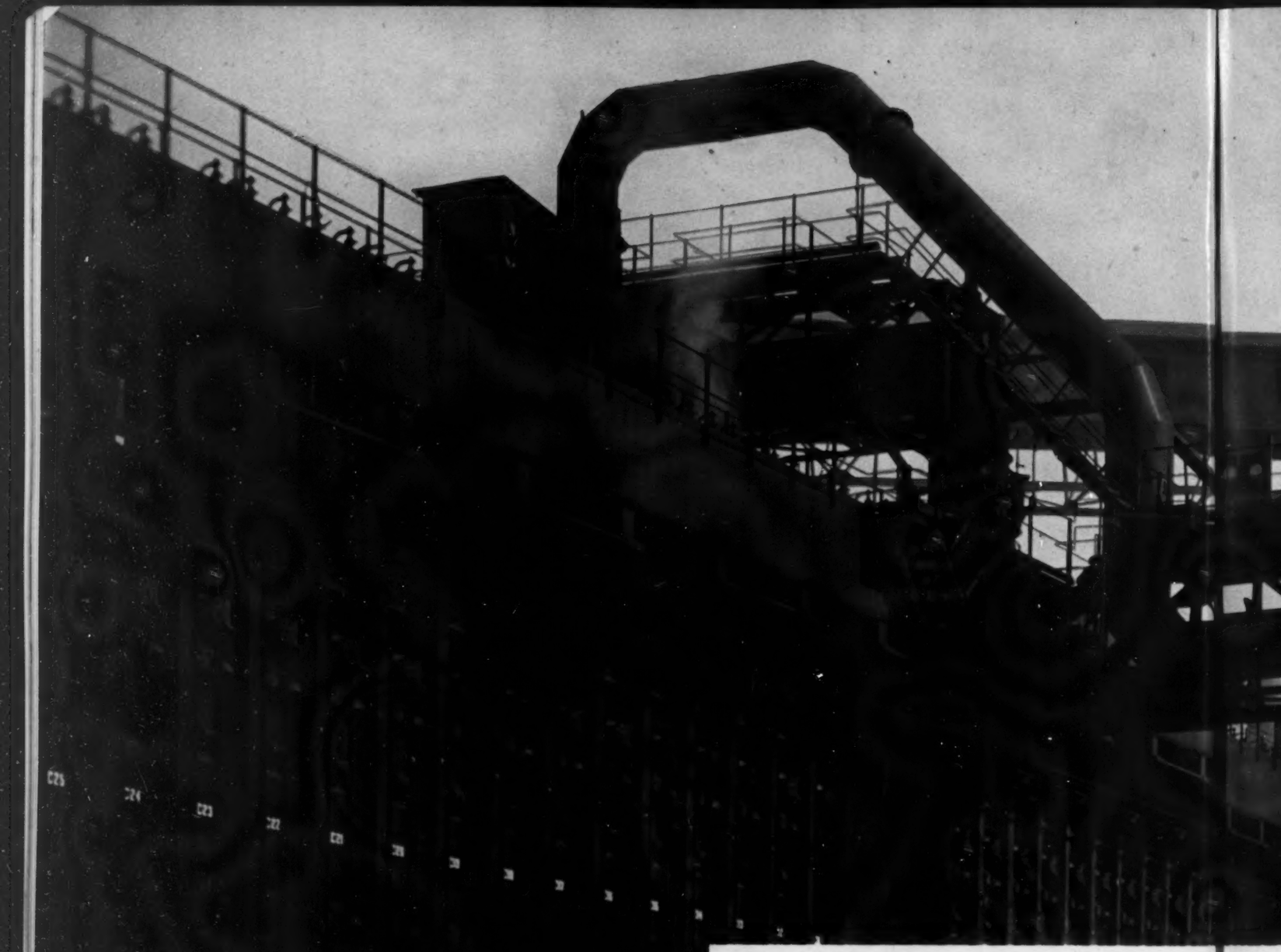


The largest coke plant in the world gets the most modern carbonizing equipment

Koppers has just completed construction of a battery of 87 Koppers-Becker Ovens for the Carnegie-Illinois Steel Corporation at its Clairton, Pa., plant, and has begun the construction of another battery of the same size at the same plant.

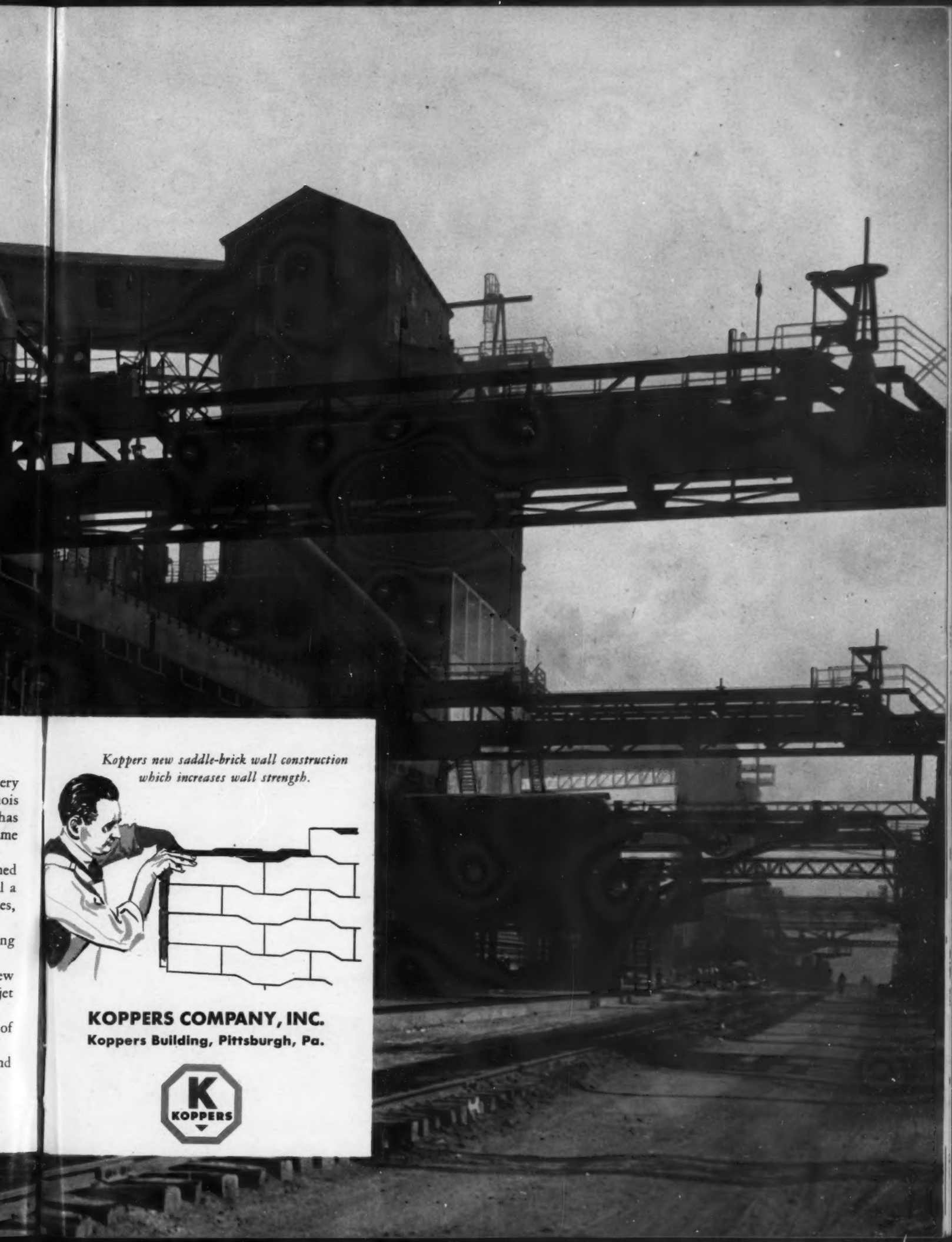
These two batteries together will have a combined coal carbonizing capacity of 1,825,000 tons of coal a year. They are the largest ovens in the United States, being 14 feet high and 18 inches average width.

The new battery is equipped with double collecting mains.

The ovens have been built with the Koppers new saddle-brick wall construction, and with underjet combustion and waste-gas recirculation.

The self-sealing doors and door machines are of the latest design.

All the ovens in this coke plant were designed and built by Koppers.



Koppers new saddle-brick wall construction which increases wall strength.

KOPPERS COMPANY, INC.

Koppers Building, Pittsburgh, Pa.

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AUTOMATIC SELF-CLEANING FILTERS

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STEEL MILLS
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. . . are efficiently filtered by the Fig. 822. Completely automatic self-cleaning saves labor and reduces downtime. Especially suited for long and continuous filtration cycles or where high capacity is required. Accommodates from two to six filtering elements. Porosities .002 to .006 of an inch, capacities 60 to 360 g.p.m.

COOLANTS . . . . . .

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Fig. 824 handles a variety of filtering jobs up to 50 g.p.m. including cutting oils, lubricating oils and other industrial liquids. Long and continuous filtration cycle. Completely automatic self-cleaning. Wide range of porosities.

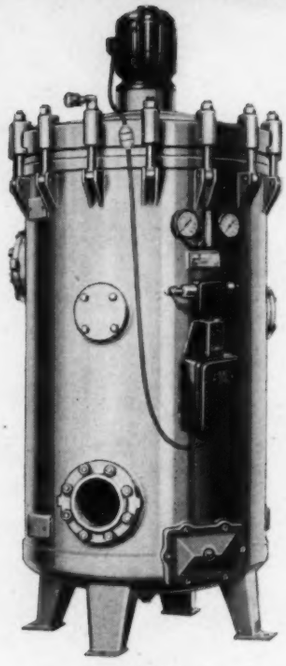

FIGURE 822

Filtering units and automatic self-cleaning system of Figure 822

The Bowser staff of engineers is available for counsel and recommendations on the specific filtering requirements of your plant. Write today.

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BLACK MAGIC

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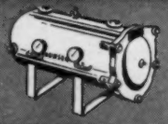

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COOLANT FILTER

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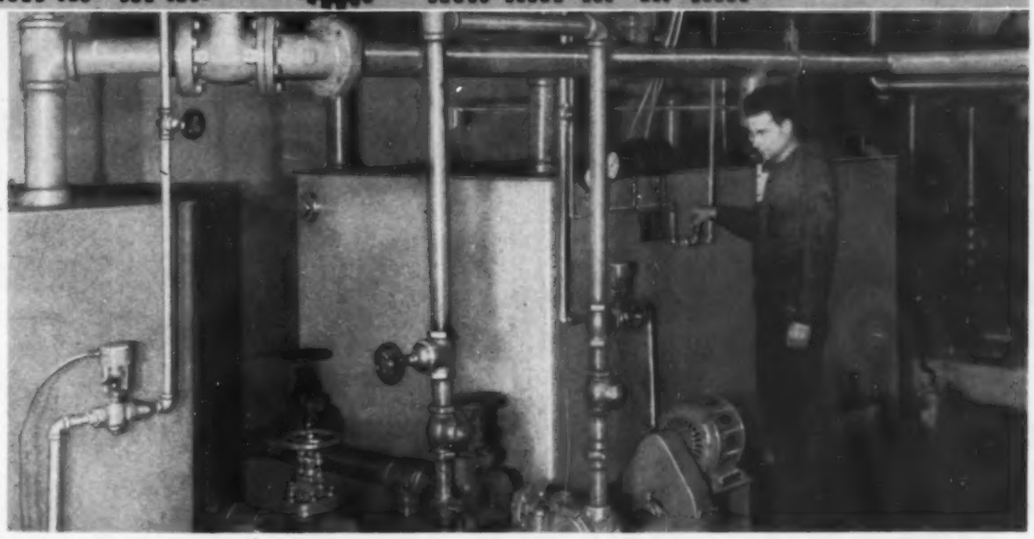
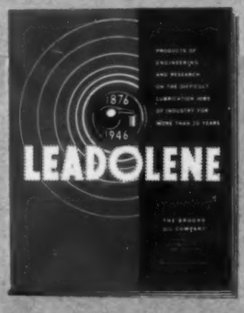


has been solving this problem for years

* LEADOLENE "I.P." LUBRICANT (INDESTRUCTIBLE pH-ilm). The stability of LEADOLENE under most difficult operating conditions prove its amazing qualities.

LEADOLENE with indestructible pH-ilm has been used continuously in many Circulating Oil Systems since 1934 *and the pH value remains neutral*—just the same as when it was introduced in the system. It lubricates efficiently in the presence of water, and under normal operating temperatures drops the water, *eliminating the need for costly centrifuging.* The tough pH-ilm strength of LEADOLENE *reduces pitting and wear* on gears, pinions and bearings to a minimum. Many long years of difficult service makes no apparent change in LEADOLENE—and it is never necessary to make seasonal changes because of atmospheric changes—*since LEADOLENE operates with the same high efficiency regardless of weather conditions.* For lower maintenance costs and longer dependable service—*specify LEADOLENE wherever ordinary lubricants have failed.*



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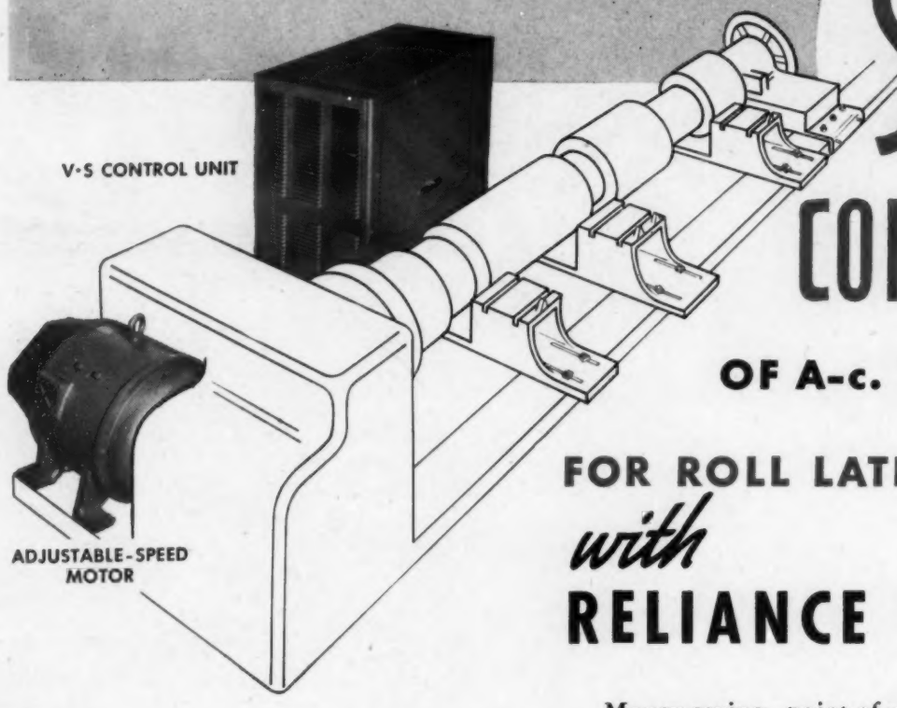
FOR ROLL LATHE OPERATION *with* RELIANCE V★S DRIVE



RELIANCE V★S DRIVE

...Conveniently-packaged, space-saving V★S Drives are available from 1 to 200 hp.

Money-saving, point-of-use conversion of A-c. power by Reliance V★S Drive is the simplest, most efficient way of securing an infinite range of stepless speed changes for roll lathe operation. V★S also provides smooth acceleration and deceleration, split-second starts and stops plus your choice of other specialized advantages. This V★S flexibility, with automatic or manual control at the machine or from remote stations, makes for greater output in numerous types of steel mill processing. Bulletin 311 will give you more important facts about V★S, the *All-electric, Adjustable-speed Drive operating from A-c. Circuits.* Send for it today!

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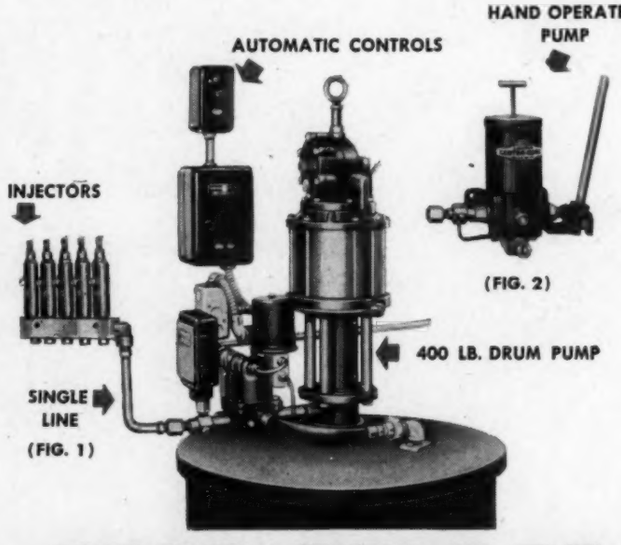
Save Bearings, Machine Hours, Man Hours, Power . . . and Prevent Accidents with these outstanding Single-Line Lubricating Systems. They assure positive lubrication with a metered quantity of lubricant to every bearing . . . No "hit or miss" methods. They are easy to install on new or old machines. Lincoln Centro-Matic Systems consist of a number of injectors—one for each bearing, a lubricant pump and a single lubricant supply line from the pump to the injectors. The pump can be time clock or push-button controlled, power operated (Fig. 1), or manually operated (Fig. 2). One lubricant pump can supply lubricant for a single machine or a battery of machines.

Lincoln Engineering Company maintains a staff of experienced lubrication engineers prepared to assist you with your lubricating problems. Complete information will be sent upon request.



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At Birdsboro it's a made to measure job when it comes to rolls. Every Birdsboro Roll is individually designed and engineered to do a specific job for you.

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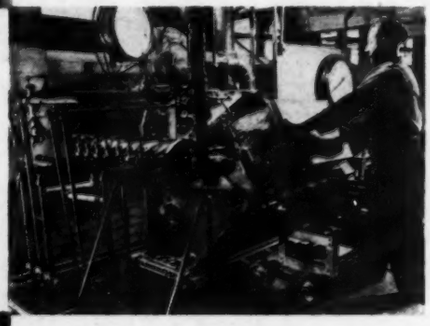
Before a single foot of Okonite cable is insulated by the strip process and vulcanized in its continuous metal mold, the seven controlled steps shown below are taken just to be sure the rubber compound has been properly processed. These and many other unusual manufacturing features make Okonite electrical wires and cables long-lived and maintenance-free. Research Publication 101, yours for the asking, tells the *whole* story. The Okonite Company, Passaic, N. J.

First, We Launder the Rubber — Multiple milling and washing rids the wild Up-river fine Para rubber of harmful impurities and water-soluble matter.

Next, It's Aged "In the Wood" — In dark rooms the rubber sheets are dried for weeks at room temperature to remove moisture without oxidation.

We Add "Balancing" Ingredients — Nearly 70 years of know-how determines the amount of selected chemicals that add "balance" to the rubber.

In the Automatic Banbury Mixer — the rubber and other compounding materials are mixed in accurate quantities and gently kneaded for a specified period.



Obtaining Smooth Compound Texture — After fine mesh screening, the compound is squeezed into paper-thin sheets to insure uniform dispersion of particles.

Then Control Room Checks the Mix — On-the-spot vulcanizing of compound from each batch provides samples for check tests before calendering.

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And the Insulation Is Finally Applied — Okonite's strip process permits complete visual inspection as the insulation strips are folded about the conductor.

OKONITE insulated wires and cables

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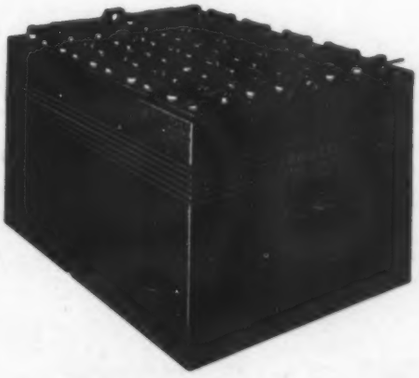
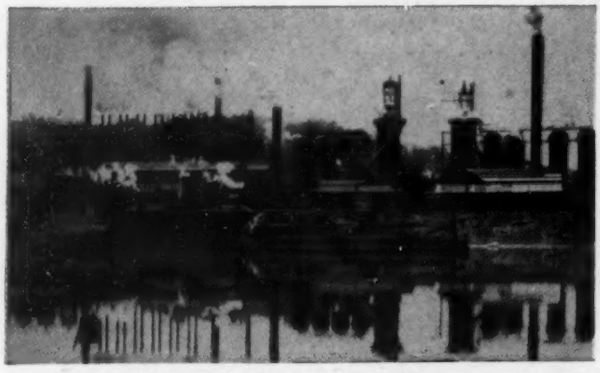
A development which has brought greater efficiency and lower costs to many users of electric trucks is the extra capacity storage battery. Pioneered by Philco, this modern improvement in batteries provides 10% or more additional capacity with no increase in overall battery size. Equip now for heavier work schedules. Write today for new catalogs giving specification data on Philco extra capacity Types XL, XVL and the famous Philco "Thirty" . . . the battery with 30% longer life.



Philco Corporation, Storage Battery Division, Trenton 7, New Jersey

PHILCO FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

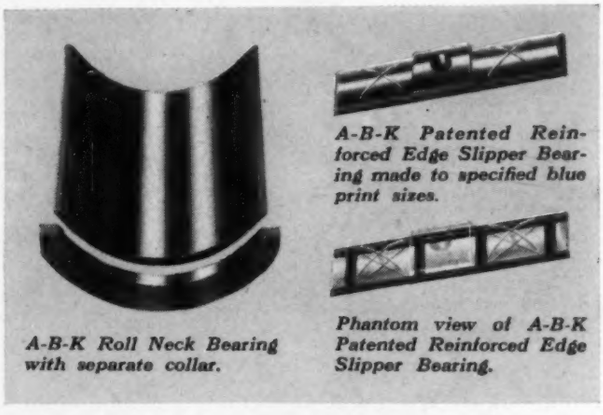
Why are steel mills switching to LAMINATED PLASTIC BEARINGS?*



1. Here's why steel mills are switching to Laminated Plastic Bearings. Records kept by many mills show laminated plastic bearings impressively superior to metal bearings. Investigate these important reasons that stand behind the trend to laminated plastic bearings. One prime consideration is that . . .

2. Laminated Plastic Bearings outwear metal bearings. These bearings customarily have a trouble-free life many times longer than metal bearings. This means fewer shutdowns for bearing replacements. Close tolerances are held with a minimum of roll adjustments. Lost production hours are substantially reduced. Then, too, . . .

3. Lubrication costs are practically eliminated. Water is used to lubricate and cool laminated plastic bearings—no oil or grease. The hard, smooth surface of these bearings, when water lubricated, has an exceptionally low coefficient of friction which results in remarkable power savings. To be sure of these advantages, . . .



A-B-K Roll Neck Bearing with separate collar.

A-B-K Patented Reinforced Edge Slipper Bearing made to specified blue print sizes.

Phantom view of A-B-K Patented Reinforced Edge Slipper Bearing.

4. It is important to specify A-B-K Laminated Plastic Bearings. American Brakeblok Division, American Brake Shoe Company, has designed and engineered A-B-K Laminated Plastic Bearings to take the severest demands of peak production. In service they have proved their ability to make surprising cuts in operating costs.

5. For full information on A-B-K Laminated Plastic Bearings and their applications to your steel mill bearing problems, communicate with American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Michigan.

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***A·B·K Laminated Plastic Bearings**

Brake Shoe

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How to get a "SWEET" CONTROL JOB

There's More to Boiler Controls Than Regulators

If you want a sweet running control for your boiler plant—look to more than bare regulators when you write your specifications. Here are some additional points to consider:

1 *Insist on controllable equipment*

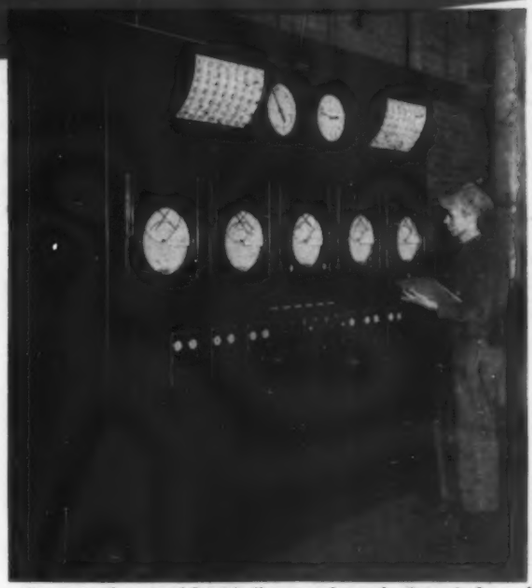
Fans, dampers, pulverizers, stokers, burners, and other equipment must be adaptable to automatic control before any system can give truly satisfactory results.

2 *Control from all important variables*

Multiple element control systems which respond to all of the important variables, insure against costly disturbances in plant operation. They increase safety, decrease auxiliary power required, and reduce the storage capacity needed in heaters and boiler drums.

3 *Profit from the experience of others*

Steam plants similar to yours already are being operated at optimum performance by Bailey Boiler Control. Your dividends, from our experience in making thousands of boiler control installations, take the form of refinements in control application which insure trouble free operation. Over 8,000 boiler units have been equipped with Bailey Controls during the past ten years. These units range from 3,000 to 1,000,000 pounds per hour capacity and operate at pressures from 75 to 2,500 psi. They are fired by pulverized coal, stokers, oil, gas, mixed fuels and waste fuels.



Control of two 65,000 lb. per hour boilers is based on the accurate measurements of these Bailey Meters at The White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

4 *Operate control from accurate measurements*

A control system is no better than the measurements to which it responds. Bailey Controls are based on accurate measurements made by Bailey Meters.

5 *Consult Qualified Application Engineers*

Bailey Engineers are qualified by training and experience to consult with you on both the theoretical and practical aspects of your boiler control problems. These specialists are conveniently located in over 30 industrial areas throughout the United States and Canada.

Details for Your Problems

If you want details write for a copy of Bulletin 15-D or ask a Bailey Engineer to call.

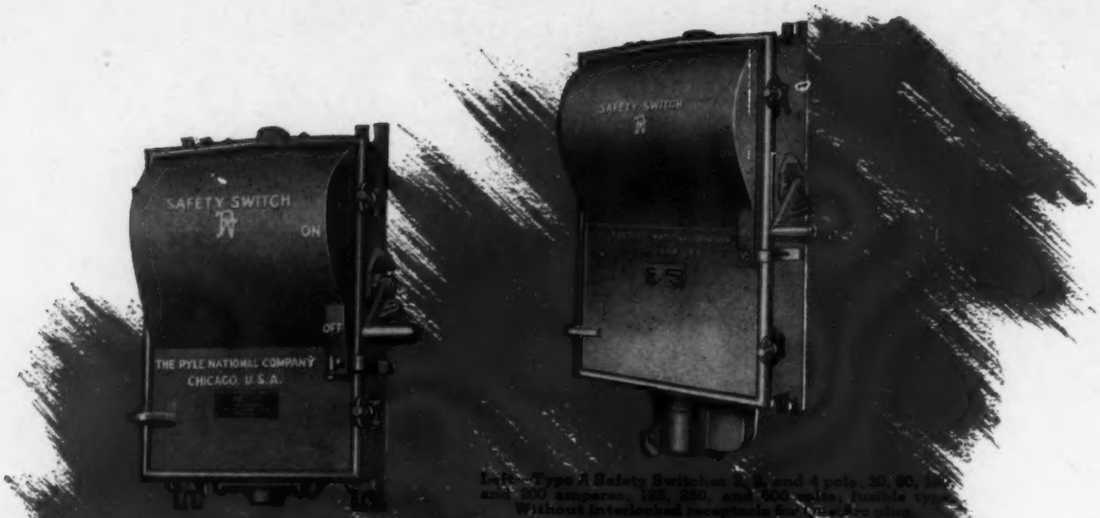
BAILEY METER COMPANY

1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

A-98-1



Left—Type A Safety Switches, 3 and 4 pole, 30, 60, 200 and 300 amperes; 100, 250, and 600 volts; fusible type. Without interlocked receptacle for QuelArc plug.
Right—Safety Switch with interlocked QuelArc plug receptacle.

Heavy-Duty Safety Switches and Circuit Breaker Pylets

BUILT FOR MILL AND RAILROAD SERVICE

Pyle-National safety switches have the substantial construction needed to withstand severe operating conditions. The case and cover are heavy-section galvanized cast iron; operating parts are of heavy cast metal, and are designed for quick make and break action. Contacts are mounted on heavy slate. The operating shaft has bronze bearings. The case is fully protected, with both cover and hub plates equipped with weatherproof gaskets. The operating lever extends through the case in a rustproof bearing, and the cover is held closed by rustproof wing nuts and bolts. These features assure dependable service and long life even under severe operating conditions.

Circuit breaker Pylet with interlocked receptacle and QuelArc plug.

Circuit breaker Pylets are of similar heavy duty construction, and are available with or without interlocking receptacle for QuelArc plugs.

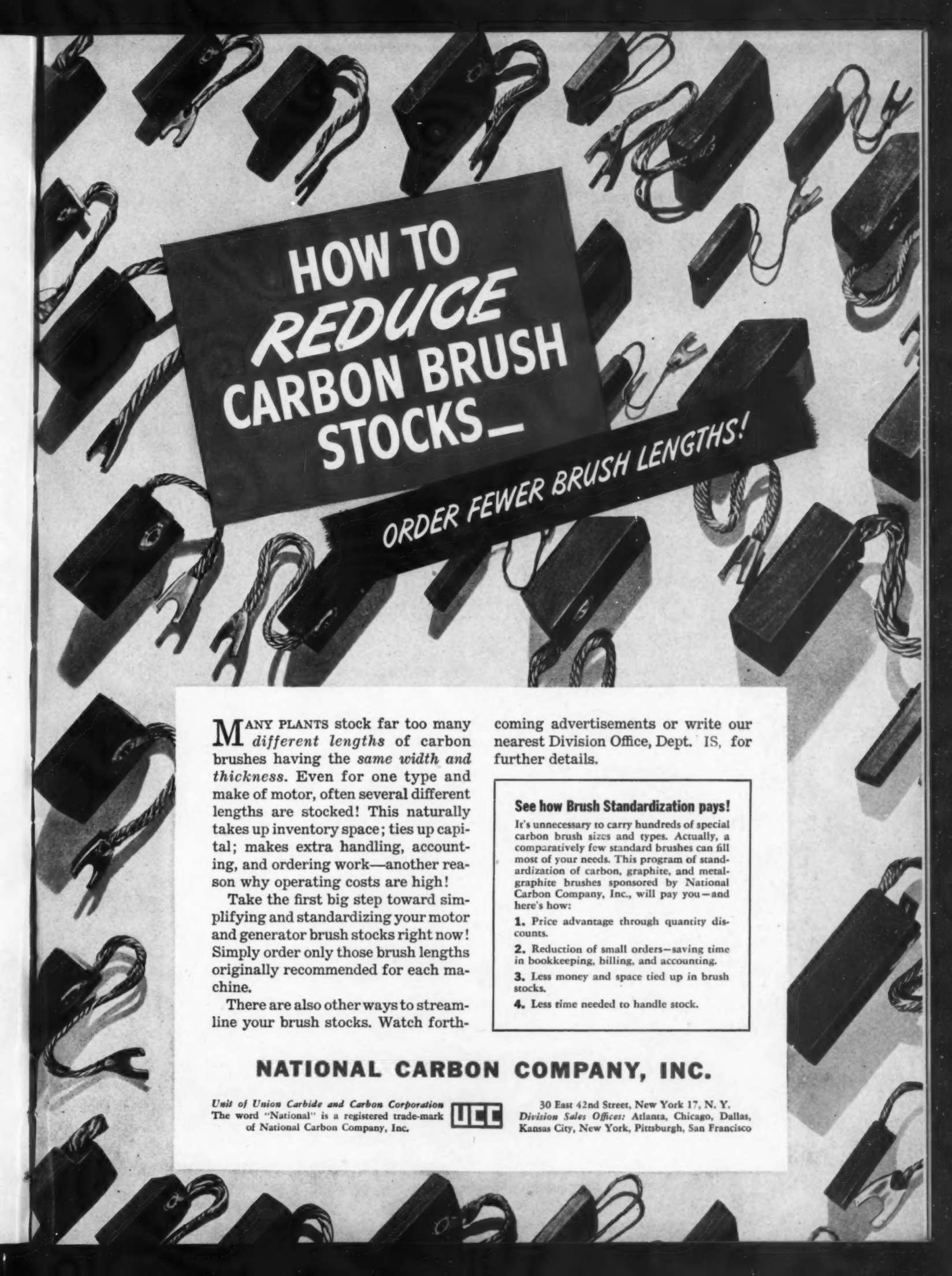
Write for Pylet general Catalog 1100 with complete listings.

PYLE-NATIONAL
ELECTRICAL EQUIPMENT
• SINCE 1897 •

THE PYLE-NATIONAL COMPANY
1334-58 North Kostner Avenue
Chicago 51, Illinois
Offices: New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

CONDUIT FITTINGS • FLOODLIGHT PROJECTORS

LOCOMOTIVE ELECTRICAL EQUIPMENT



MANY PLANTS stock far too many *different lengths* of carbon brushes having the *same width and thickness*. Even for one type and make of motor, often several different lengths are stocked! This naturally takes up inventory space; ties up capital; makes extra handling, accounting, and ordering work—another reason why operating costs are high!

Take the first big step toward simplifying and standardizing your motor and generator brush stocks right now! Simply order only those brush lengths originally recommended for each machine.

There are also other ways to streamline your brush stocks. Watch forthcoming advertisements or write our nearest Division Office, Dept. IS, for further details.

See how Brush Standardization pays!

It's unnecessary to carry hundreds of special carbon brush sizes and types. Actually, a comparatively few standard brushes can fill most of your needs. This program of standardization of carbon, graphite, and metal-graphite brushes sponsored by National Carbon Company, Inc., will pay you—and here's how:

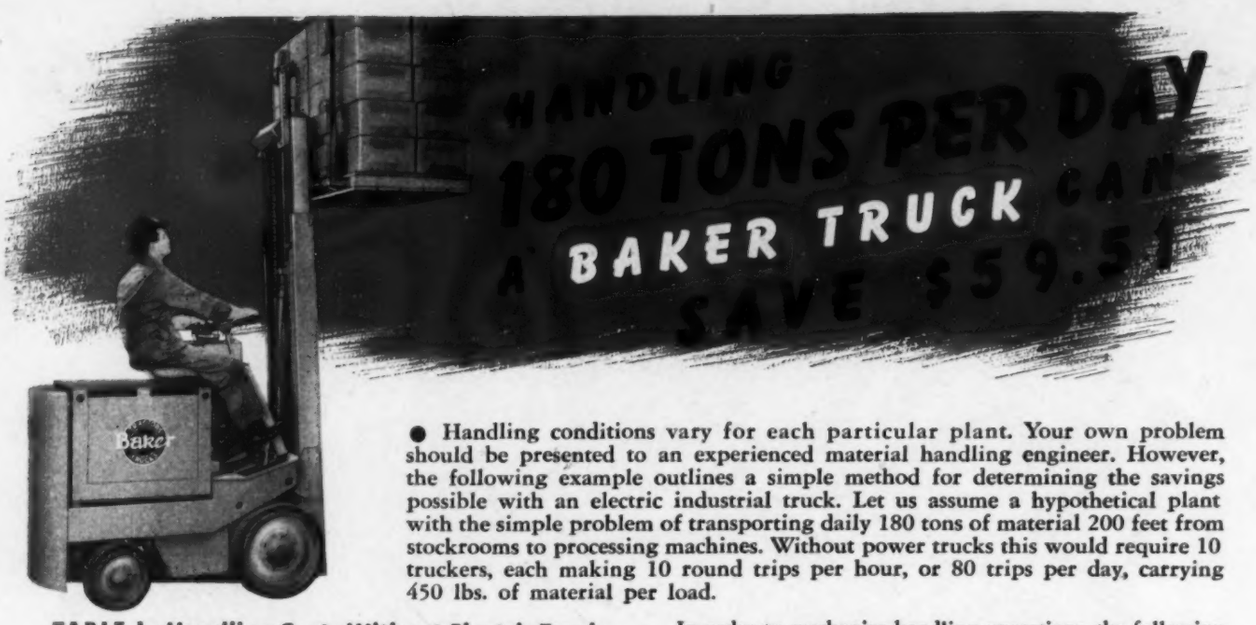
1. Price advantage through quantity discounts.
2. Reduction of small orders—saving time in bookkeeping, billing, and accounting.
3. Less money and space tied up in brush stocks.
4. Less time needed to handle stock.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
The word "National" is a registered trade-mark of National Carbon Company, Inc.

UCC

30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco



● Handling conditions vary for each particular plant. Your own problem should be presented to an experienced material handling engineer. However, the following example outlines a simple method for determining the savings possible with an electric industrial truck. Let us assume a hypothetical plant with the simple problem of transporting daily 180 tons of material 200 feet from stockrooms to processing machines. Without power trucks this would require 10 truckers, each making 10 round trips per hour, or 80 trips per day, carrying 450 lbs. of material per load.

TABLE I—*Handling Costs Without Electric Truck*

Based on 180 tons per day	*Cost per day*	*Cost per ton*
Labor (85¢ per hour)	$68.00	$0.378
Social Security Taxes	2.72	0.015
Workmen's Compensation	1.00	0.006
Hand Truck Depreciation	0.30	0.002
Total	$72.02	$0.401

COST OF MATERIAL HANDLING

Per ton—based on 180 tons per day

In addition to these savings, Baker Trucks reduce warehouse rental charges by tiering, contribute to plant safety, speed production and material movement, and perform many other operations that reduce plant overhead.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Company
2166 WEST 25TH STREET • CLEVELAND, OHIO
In Canada: Railway and Power Engineering Corporation, Ltd.

In order to mechanize handling operations, the following equipment would be required:

TABLE II—*Cost of Equipment for Mechanizing*

Fork Lift Truck 2000-lb. capacity	$4,100.00
Battery	600.00
Charging Equipment	840.00
200 pallets	700.00
Total	$6,240.00

The truck, handling one-ton pallet loads of material, making 24 round trips per hour, could transport the 180 tons in 7½ hours.

TABLE III—*Annual Expense—Truck Operation*

Depreciation—Truck at 10%	$410.00
Battery at 20%	120.00
Charging equipment at 6⅔%	56.00
Pallets at 20%	140.00
Tires	100.00
Repair and Maintenance—Truck	164.00
Battery	24.00
Charging Equipment	33.60
Replacement of damaged pallets	70.00
Electricity	82.00
Insurance	10.00
Total annual expense	$1,209.60
Expense per day	4.03

TABLE IV—*Handling Costs—With Electric Truck*

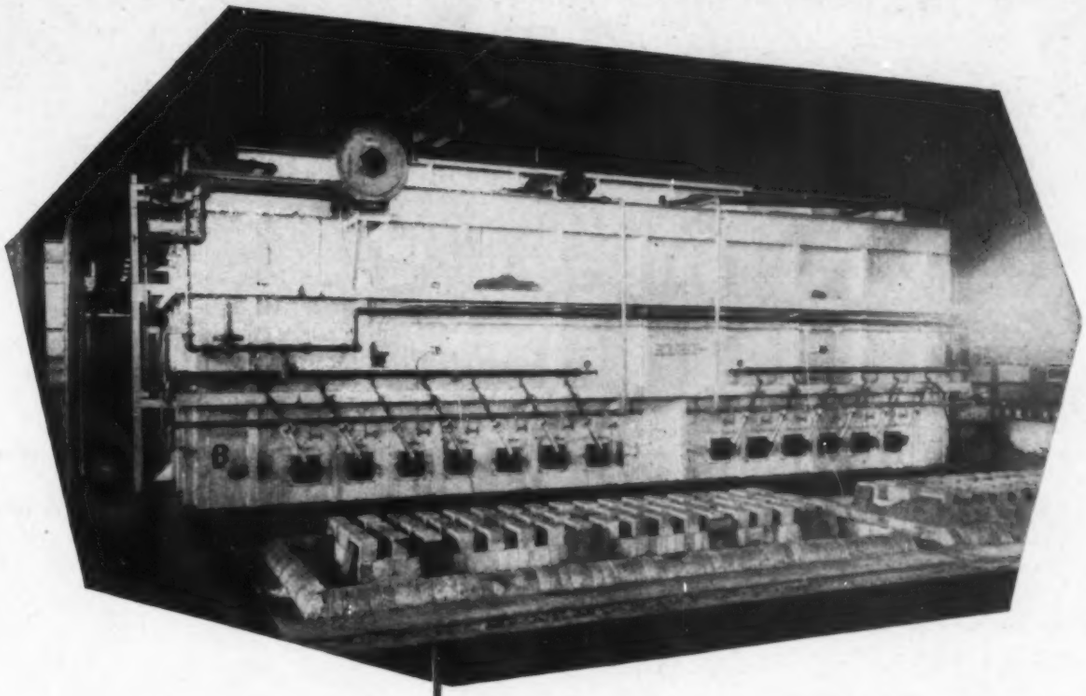
Based on 180 tons per day	*Cost per day*	*Cost per ton*
Labor (Driver—$1 per hour)	$8.00	$0.044
Social Security Taxes	0.32	0.002
Workmen's Compensation	0.16	0.001
Truck Expense	4.03	0.022
Total	$12.51	$0.069

TABLE V—*Savings With Electric Truck*

Savings Per Ton	$ 0.332
Savings Per Day (Handling 180 tons)	59.51
Savings Per Year (300 days)	17,853.00
Per cent Reduction in handling costs	83%
Annual earnings on investment	286%

While this example is obviously oversimplified, Baker Material Handling Engineers are prepared to show you how similar savings can be made on handling operations in your plant.

ARE YOU GETTING
MAXIMUM PRODUCTION
FROM YOUR PRESENT EQUIPMENT?



F. E. I.
Equipment

- Direct Fired Cover Furnaces for Annealing, Spheroidizing, Normalizing and Bright Annealing of wire, rods, coiled strip, flat sheets or tin plate.
- Convection Bases especially designed for heavy coil loads, give 200% to 400% longer life.
- Galvanizing, Patenting and Normalizing Furnaces for WIRE, BAR, and TUBE MILLS.
- Galvanizing Furnaces for Pipe, Sheet and Job Plants.

The above cover annealing furnace for sheets in a representative steel plant was converted to our Direct Fired Combustion System and immediately resulted in an increase in production of over 50%, eliminated top stickers and improved metallurgical quality. At the present time every furnace in this department has been converted to our system. We ought to be able to do the same for you.

This increase in production is possible because we have introduced new principles of heat application in the metals producing field. These principles are applicable to the Wire, Rod, Sheet, Strip, Bar and Galvanizing Industries. For applicability of F.E.I. Direct Fired Combustion Systems to your present equipment write, wire or phone for further information.

F.E.I.

FURNACE ENGINEERS, *Inc.*

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

Wagner "ALL-IN-ONE"

The Modern UNIT SUBSTATION

SIMPLIFIES THE PLANNING, PURCHASE, and INSTALLATION of POWER DISTRIBUTION EQUIPMENT

This one unit comprises a complete substation with air-cooled transformer, H. V. disconnect switch and L. V. circuit breakers—all compactly arranged in an attractive steel cabinet.

Engineered as a single unit, ready to connect to the line, this modern substation provides several important money-saving advantages in the distribution of electric power in factories, office buildings, hospitals, department stores, schools, etc. You save on first cost because no extra engineering and less labor costs are involved. You save on installation cost because the ALL-IN-ONE substation is delivered as a complete, easy-to-handle unit, ready to connect to the line. Neither fireproof vault nor safety fence is required. You save on maintenance as there is no insulating liquid to test, filter, or change. Panels can be easily removed for quick inspection.

There are no external bushings—no rods, wires, or other exposed live parts to offer a safety hazard. This indoor unit assembly makes a neat, attractive installation anywhere. It can be placed at load centers to shorten low-voltage feeder lines, thus effecting a substantial saving of copper, and at the same time improving voltage regulation of lighting and power circuits.

The ALL-IN-ONE substation is furnished in sizes 100 to 300 kva, 60 cycles, with several combinations of H. V. and L. V. ratings. For sizes above 300 kva Wagner Multumite Unit Substations offer substantially the same money-saving, time-saving advantages as the smaller ALL-IN-ONE substations.

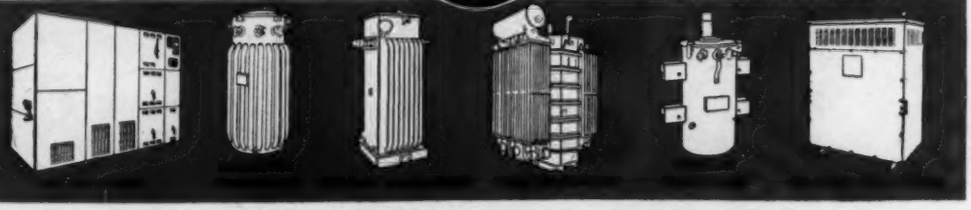
For more information on Wagner ALL-IN-ONE substations and Wagner Multumite unit substations write today, addressing your request to Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Missouri. T46-24

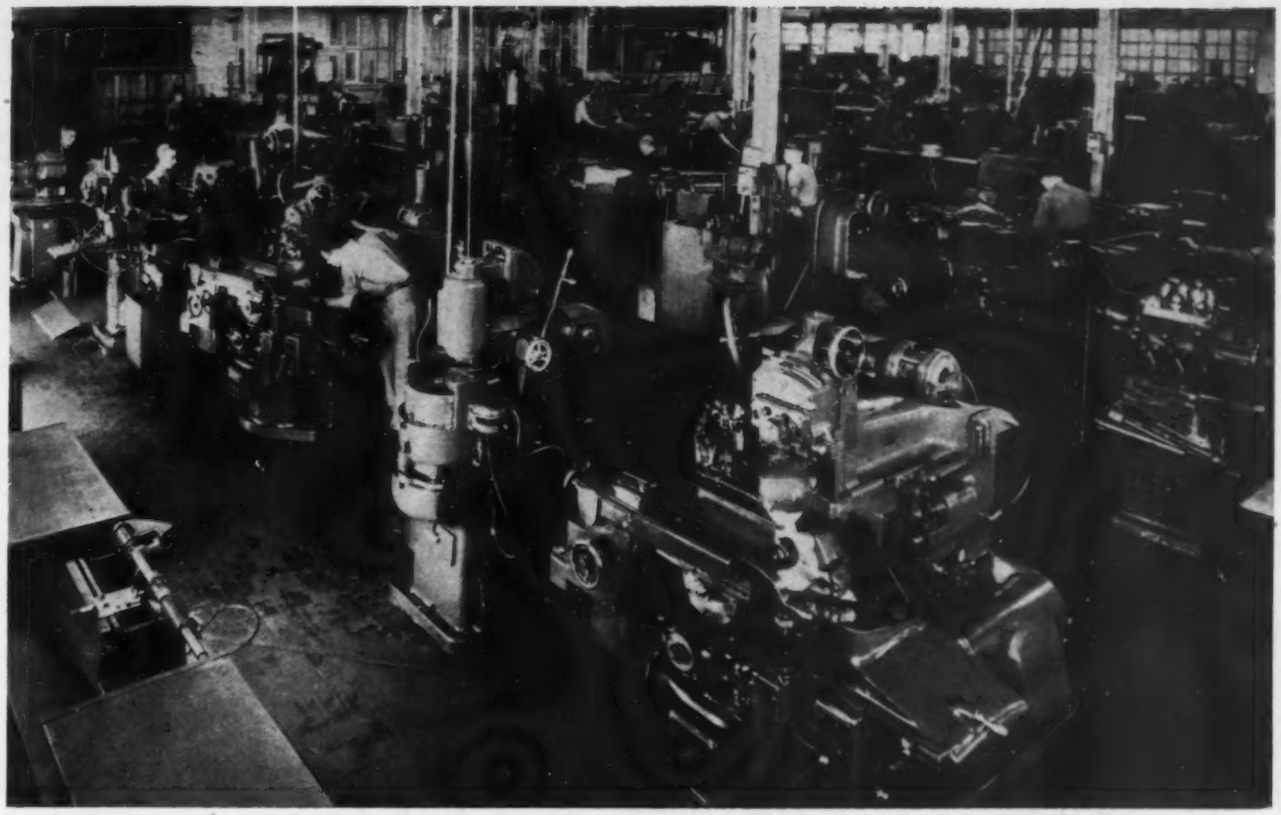
Consult Wagner Engineers on all Transformer Problems

Sales and Service Branches: Atlanta 3 • Baltimore 18 Boston 15 • Buffalo 8 • Chicago 16 • Cincinnati 10 Cleveland 15 • Dallas 1 Denver 2 • Detroit 2 • Houston 2 • Indianapolis 4 Kansas City 8 • Los Angeles 15 • Memphis 3 • Milwaukee 2 • Minneapolis 4 • New York 7 • Omaha 2 • Philadelphia 8 • Pittsburgh 13 Portland 9 • St. Louis 3 • Salt Lake City 1 • San Francisco 3 Seattle 4 • Syracuse 2 • Tulsa 3 • Washington D. C. 5
In Canada: Wagner Electric at Leaside, Ontario

Wagner LOCKHEED HYDRAULIC BRAKE PARTS and FLUID...NoRoL...CoMaX BRAKE LINING

WE **Electric** AIR BRAKES...TACHOGRAPHS...INDUSTRIAL BRAKES...ELECTRIC MOTORS...TRANSFORMERS





THIS HYDRAULIC OIL { Prevents Sludge / Prevents Rust / Prevents Stoppages

TEXACO *Regal Oils (R & O)* for hydraulic systems, in the viscosities recommended for your particular equipment, will prevent costly stoppages caused by sludge and rust.

Texaco Regal Oils (R & O) are strongly inhibited against rust and oxidation . . . free themselves rapidly of air and water . . . prevent sludge formation. They "plate" interior mechanisms so that moisture cannot reach and rust the metal.

In addition, *Regal Oils (R&O)* will not foam. This means smooth, dependable operation.

Leading makers of hydraulic equipment recommend or approve the use of *Texaco Regal Oils (R & O).* They are available over a range of viscosities to assure trouble-free, economical performance of the largest to the smallest hydraulic units.

For full information, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Regal Oils (R&O)

FOR ALL HYDRAULIC UNITS

Tune in . . . TEXACO STAR THEATRE presents the NEW EDDIE BRACKEN SHOW every Sunday night. Metropolitan Opera broadcasts every Saturday afternoon.

Vaportight CONDULETS

for electrical installations that are exposed to weather, moisture, steam or non-combustible dust

The illustrations show a representative selection from the hundreds of different Vaportight Condulets that are listed in Crouse-Hinds Condulet Catalog 2500. Many other Condulets can be furnished with gaskets that make them Vaportight and Weatherproof.

CONDULETS are made only by CROUSE-HINDS

No. 10
of a series of advertisements which demonstrate that CROUSE-HINDS "complete line" means much more than just a range of sizes—there is a wide variety of highly specialized types in each classification.

Type X Obround Condulet with Vaportight Gasket

Type AHG Vaportight Flexible Fixture Hanger

Type FSC Condulet with Vaportight Gasket

Type FS Vaportight Switch Condulet

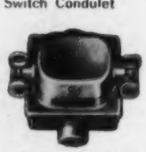
Type GSC Condulet with Vaportight Gasket

Type FD Vaportight Switch Condulet

Type GRT Condulet with Vaportight Gasket

Type FD Vaportight Switch Condulet

Type C Obround Condulet with Vaportight Switch


Type FS Two-Gang Vaportight Switch Condulet

Type FS Vaportight Triple Switch Condulet

Type FSC Two-Gang Tandem Condulet with Vaportight Switch and Threaded Cap Plug Receptacle

Type FSC Vaportight Push Button Station Condulet

Type FS Vaportight Lighting Fixture

Type FSC Vaportight Plug Receptacle Condulet

Type VPH Vaportight Indirect Lighting Condulet

Type VDB Vaportight Lighting Condulet 500-Watt

Type ARB Vaportight Lighting Fixture for GRF Series Condulets

Type V Vaportight Lighting Condulet for mounting on machines

Type V Vaportight Heavy Duty Lighting Condulet with Shatterproof glass for use in the food industry

Type GS Vaportight Lighting Fixture for GS Series Condulets

Type VDA Vaportight Tank or Vat Light

Type VG Vaportight Lighting Condulet

Type ARC Vaportight Lighting Fixture for Obround Condulets

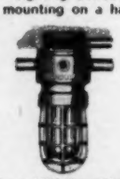
Type GS Vaportight Lighting Fixture for GS Series Condulets

Type VC Vaportight Lighting Condulet

Type VDA Vaportight Lighting Condulet with Dome Reflector

Type VXHA Vaportight Lighting Condulet with flush hubs

Type VR Vaportight Lighting Condulet for mounting on a hand rail


Type VXJ Vaportight Lighting Condulet for making extenstons from concealed conduit wiring

Type VS Vaportight Hand Lamp with Rubber Handle

Type V Vaportight Lighting Condulet with Dome Reflector

Type RCD-8 Vaportight Lighting Fixture for wall mounting

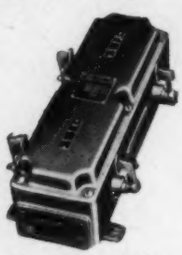
Type VFC Vaportight Gauge Lighting Condulet

Type WV Vaportight Lighting Condulet with Fresnel Lens

Type VJ Vaportight Lighting Condulet

Type VLG Vaportight Gauge Lighting Condulet Fluorescent

Type VDA Vaportight Lighting Condulet with Angle Reflector


Type YSW Vaportight Circuit Breaker Condulet

Type DVS Dust-Tight and Vaportight Circuit Breaker Condulet

Type DVS Dust-Tight and Vaportight Circuit Breaker Condulet

Type DVP Dust-Tight and Vaportight Panelboard

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
Syracuse 1, N. Y., U.S.A.

Offices: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington. *Resident Sales Engineers:* Albany — Atlanta — Charlotte — Indianapolis — New Orleans
CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

More Merchant Mills

on the way

by Continental

Continental

FOUNDRY & MACHINE CO.

PITTSBURGH · CHICAGO

Plants at: E. Chicago, Ind.; Wheeling, W. Va.; Pittsburgh, Pa.

Air-Cooled Slag-pot Cradle

Continental

Multiple heat dissipating vertical ribs add great strength to sidewalls, promote rapid air cooling. Cradle type trunnion ring and support permits sidewalls to 'breathe' within the ring. A major improvement—proved in service.

CHECK First with

Precision Castings

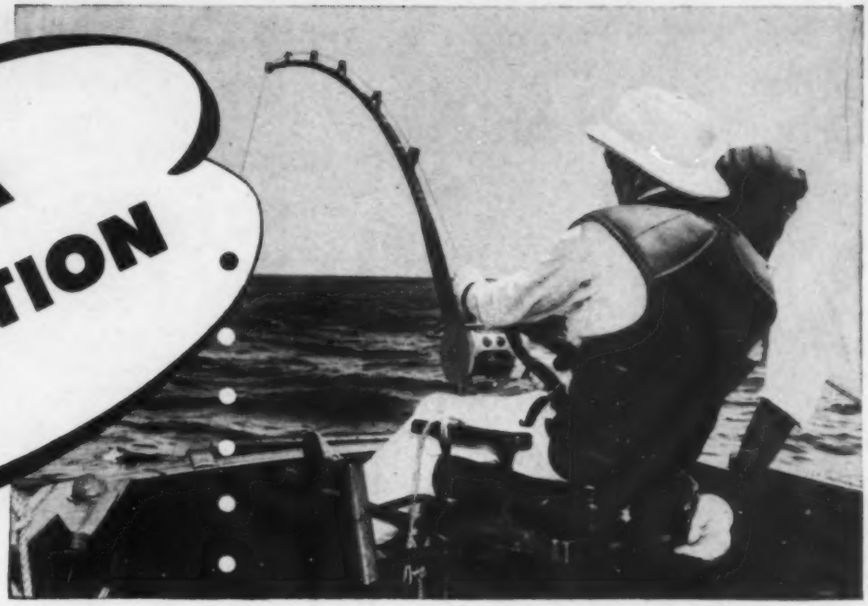
Continental

FOUNDRY & MACHINE CO.

PITTSBURGH · CHICAGO

Plants at: E. Chicago, Ind.; Wheeling, W. Va.; Pittsburgh, Pa.

EXTRA PROTECTION

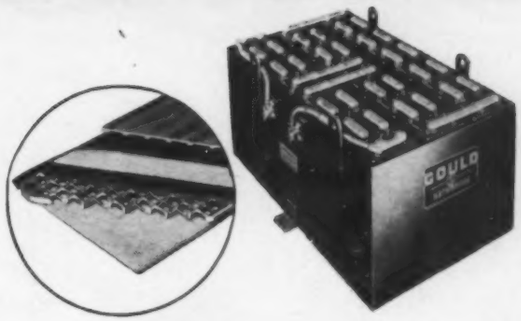


Gould Batteries Give Extra Protection

In Gould Kathanode Batteries all useful active material is retained in the grid

Just as deep sea fishermen wear a special harness to absorb the pull of big fish, so is Kathanode reinforced against the strains of charging and discharging in industrial truck service. For Kathanode this extra protection maintains capacity for the entire service life of the battery.

MEMO
Materials Handling Supervisor —
More Gould Kathanode Batteries are surely built to meet our tough handling schedules.
BATTERY INSPECTOR



and here is the Reason why—

In Gould Kathanode each positive plate is faced with spun glass mats, held in place by a porous rubber envelope. This is the famous Kathanode unit. It keeps the active material in place until it is entirely spent, where without this special construction the oxide would flake off before being spent, and settle to the bottom. Prove this yourself by comparing the sediment in a Gould battery with any other battery not having glass mats.

Get all the facts on Gould. Write Dept. 412 for Catalog 100 on Gould Kathanode Glassklad Batteries for Industrial Truck and Tractor Service.

GOULD
KATHANODE
BATTERIES

GOULD STORAGE BATTERY CORPORATION, Depew, N. Y. Service Centers: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland Detroit • Kansas City • Los Angeles • New York • Philadelphia • Pittsburgh St. Louis • St. Paul • San Francisco • Seattle • Zanesville

THE world's largest builder of the world's largest cranes has developed many new Safety and Mechanical features now incorporated as standard practice in steel mill cranes. Replaceable bronze bearings . . . all-steel construction cranes including cast steel drums . . . a new system of reeving ropes for ladle cranes . . . these and many other features accepted as conventional today, were original with Alliance.

It will pay you to check with Alliance—for the development of new cranes or reconversion of old cranes to give your plants more lifting power. Rely on Alliance—for fifty-odd years the world's largest builder of the world's largest cranes.

THE ALLIANCE MACHINE COMPANY

ALLIANCE, OHIO · 1622 OLIVER BUILDING, PITTSBURGH, PA.

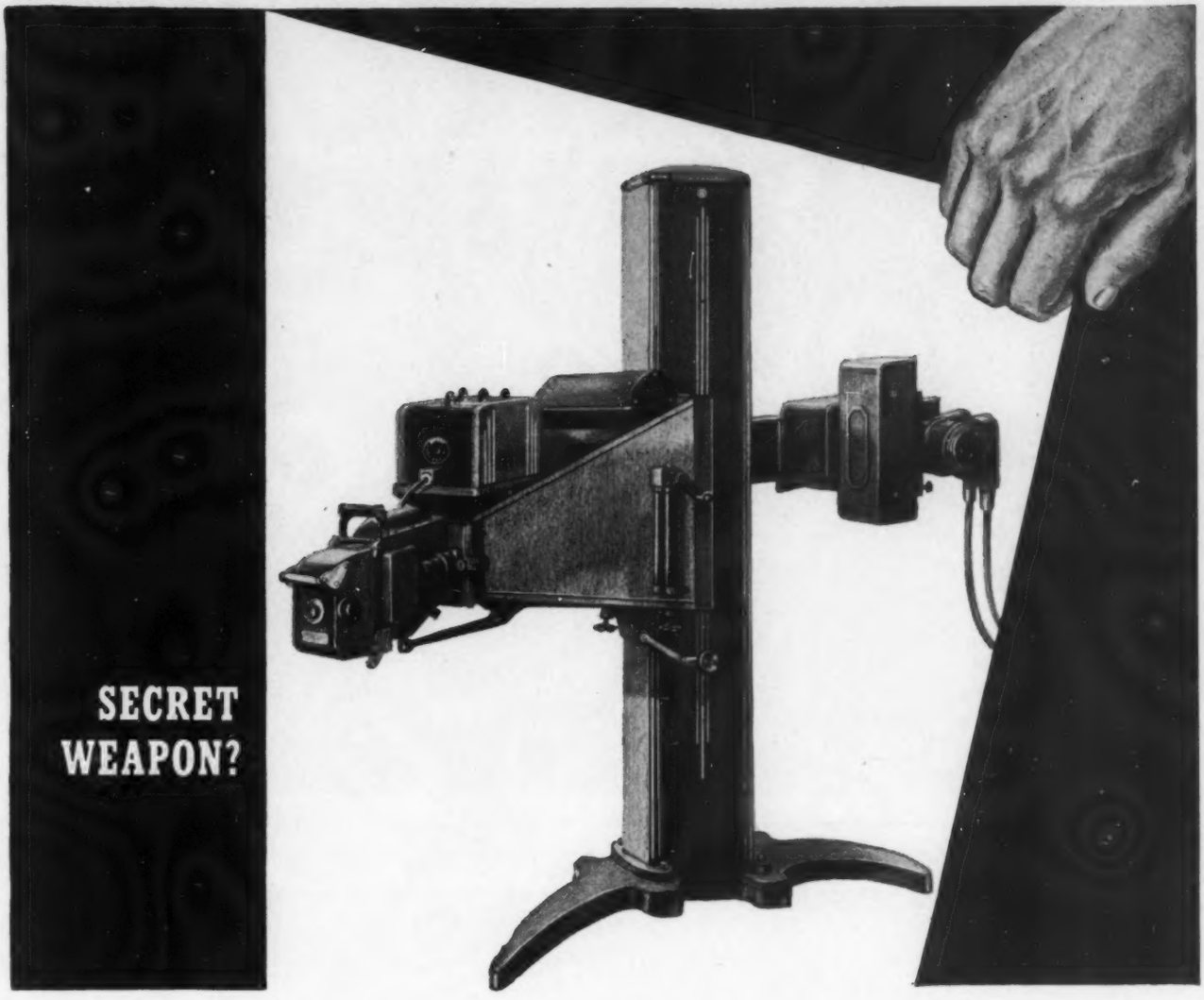
LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS

SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET

CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES

SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION

Alliance



Here's one "secret weapon" that needs to be unveiled in every corner of the land...

THE ENEMY: Tuberculosis, the dread White Plague which kills more Americans between 15 and 35 than any other disease.

THE WEAPON: The X-ray, surest means of catching TB early, when it can be cured more easily and before it spreads.

Christmas Seal money fights TB in many ways; one of the most important is to buy X-ray units and promote mass examinations. Please, send in your contribution today.

BUY CHRISTMAS SEALS

Because of the importance of the above message, this space has been contributed by *IRON AND STEEL ENGINEER*

* A Family at Work *

THESE Pennsylvania Power Transformers are working for a large Eastern steel mill. Their job is to provide a steady stream of unfailing power to large furnace transformers. To do this job well, they are equipped with over-sized bushings (115 KV) to nullify atmospheric conditions around the steel mills. Two safety valves provide an added measure of protection. Radiators are generously spaced around the tanks to simplify cleaning and painting. The 25,000 Kva transformers are provided with conduits and mountings for the future addition of forced air cooling equipment to increase capacity to 33,333 Kva. Like thousands of other Pennsylvania Transformers, these have worked throughout the war years, and are still on the job giving dependable, reliable service.

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVENUE • PITTSBURGH 12, PENNSYLVANIA

Pennsylvania TRANSFORMERS

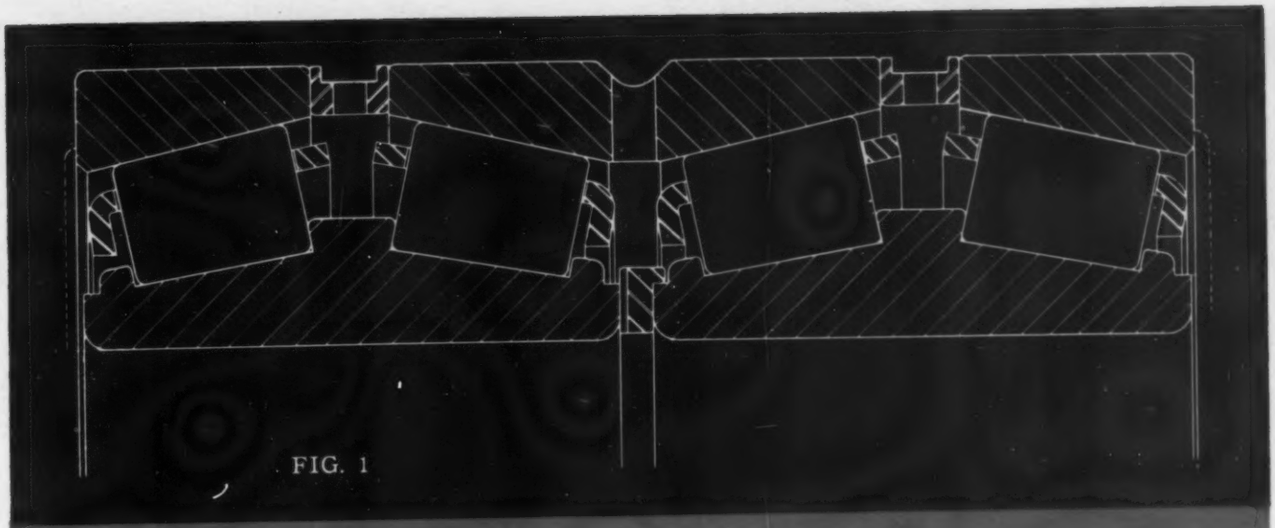


FIG. 1

A CONVINCING COMPARISON

Figure 1 shows a Timken 4-row roll neck bearing as installed in an 18" 2-high bar mill in the Detroit area. This bearing has an outside diameter of 16⅝", a bore of 10¼" and a width of 12½". Its radial rating is 228,000 lbs. at 100 R.P.M. for bar mill use.

Figure 2 shows a Timken 4-row "Balanced Proportion" Bearing which now would be recommended for this size mill. This bearing has the same outside diameter, but provides a bore of 11-13/16" and a width of 12¼". It has a radial rating of 310,000 lbs. at 100 R.P.M. — an increase of 36% over the present bearing and a resulting life expectancy 2.83 times as great. Its bore is 15% larger, which shows a 36% reduction in neck stress.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

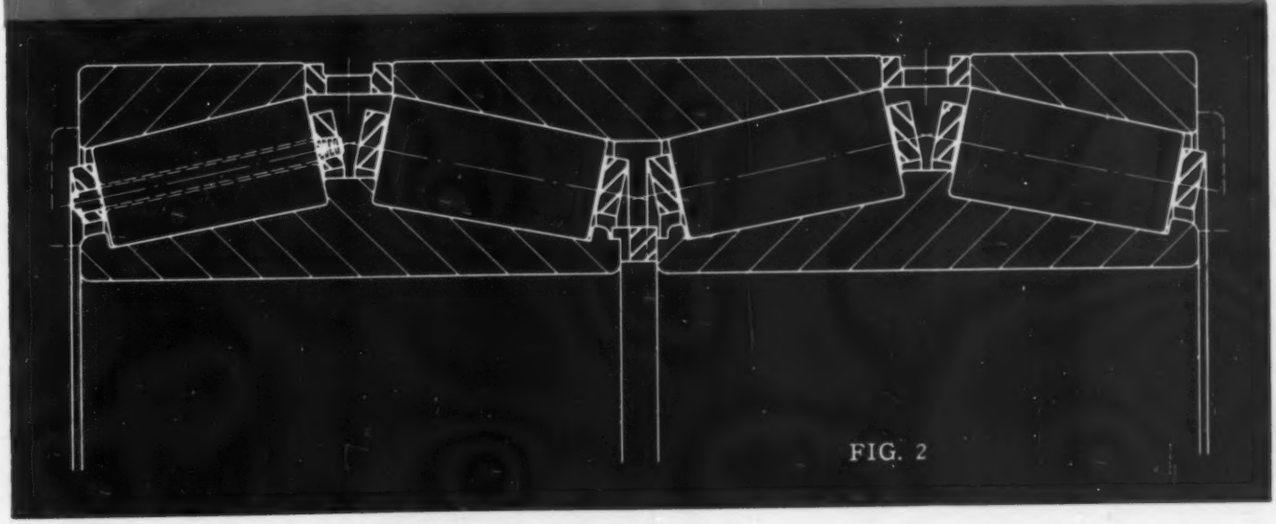


FIG. 2

No sag...no drag...Coils ride safely and gently on LINK-BELT Conveyors

Coils that ride the Link-Belt Conveyor make their trip safely. Ample bearing surfaces and sturdy construction prevent the sag and drag that scuff strip edges. Telescoping is eliminated and the reduction in edge damage has a marked effect on scrap losses; accomplishing a reduction in the cost of tin plate production.

Link-Belt conveyors offer carefree operation. Ruggedly built, smooth running, Link-Belt offers designs for handling coils in various positions, allowing complete flexibility in mechanical handling.

Discuss your plans for mill modernization with a Link-Belt Engineer, the man backed by broad experience in your materials handling problems.

SERVICE TO STEEL BY LINK-BELT . .

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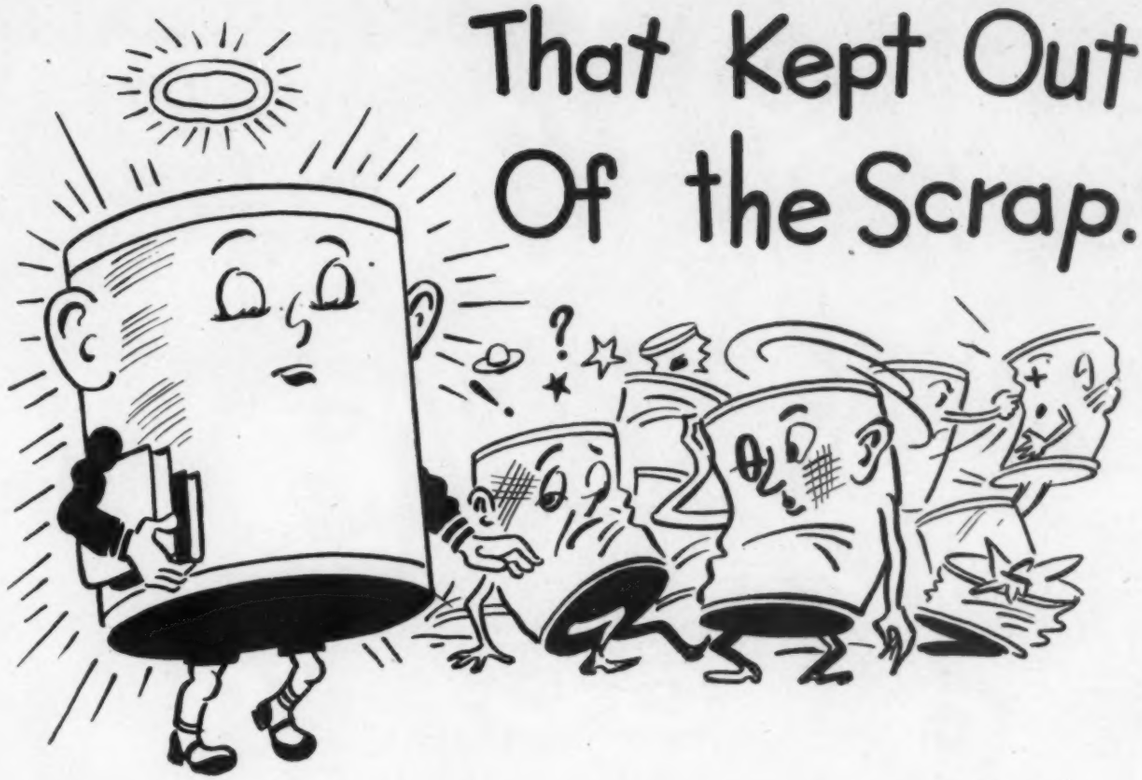

IT COULD HAVE BEEN "CURTAINS" for the Tin Can — and in the final stages of production, too — if its shiny coat had been spoiled in the "Reflow" process which follows the electrolytic tinning line.

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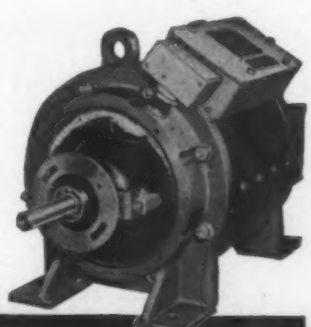

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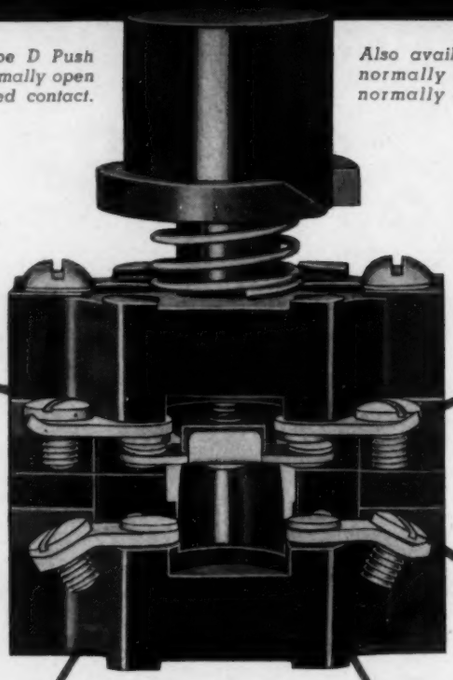

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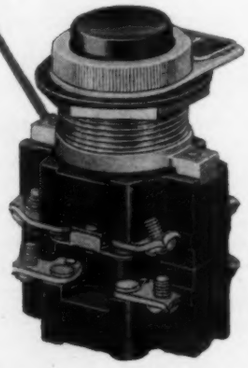

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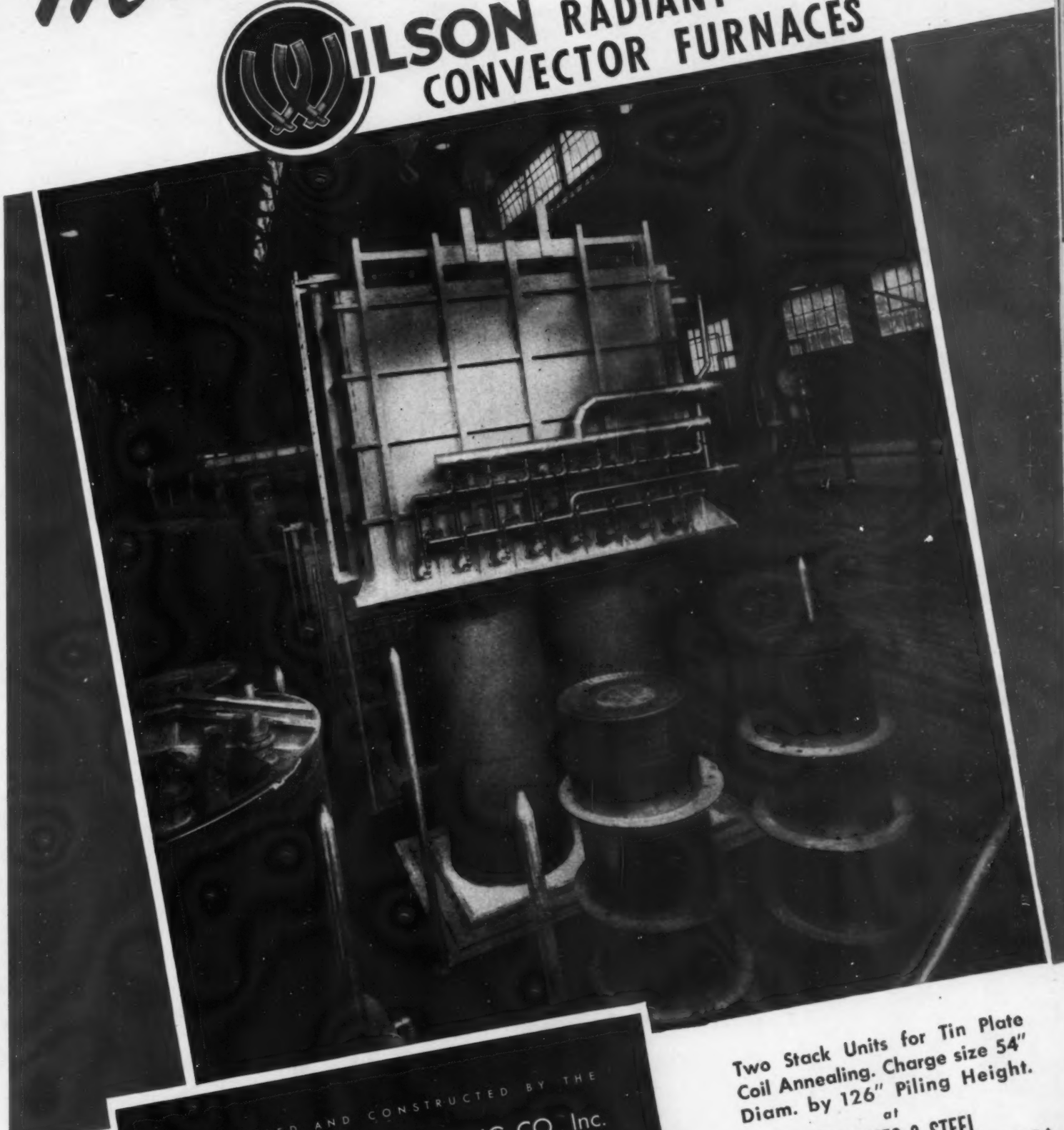

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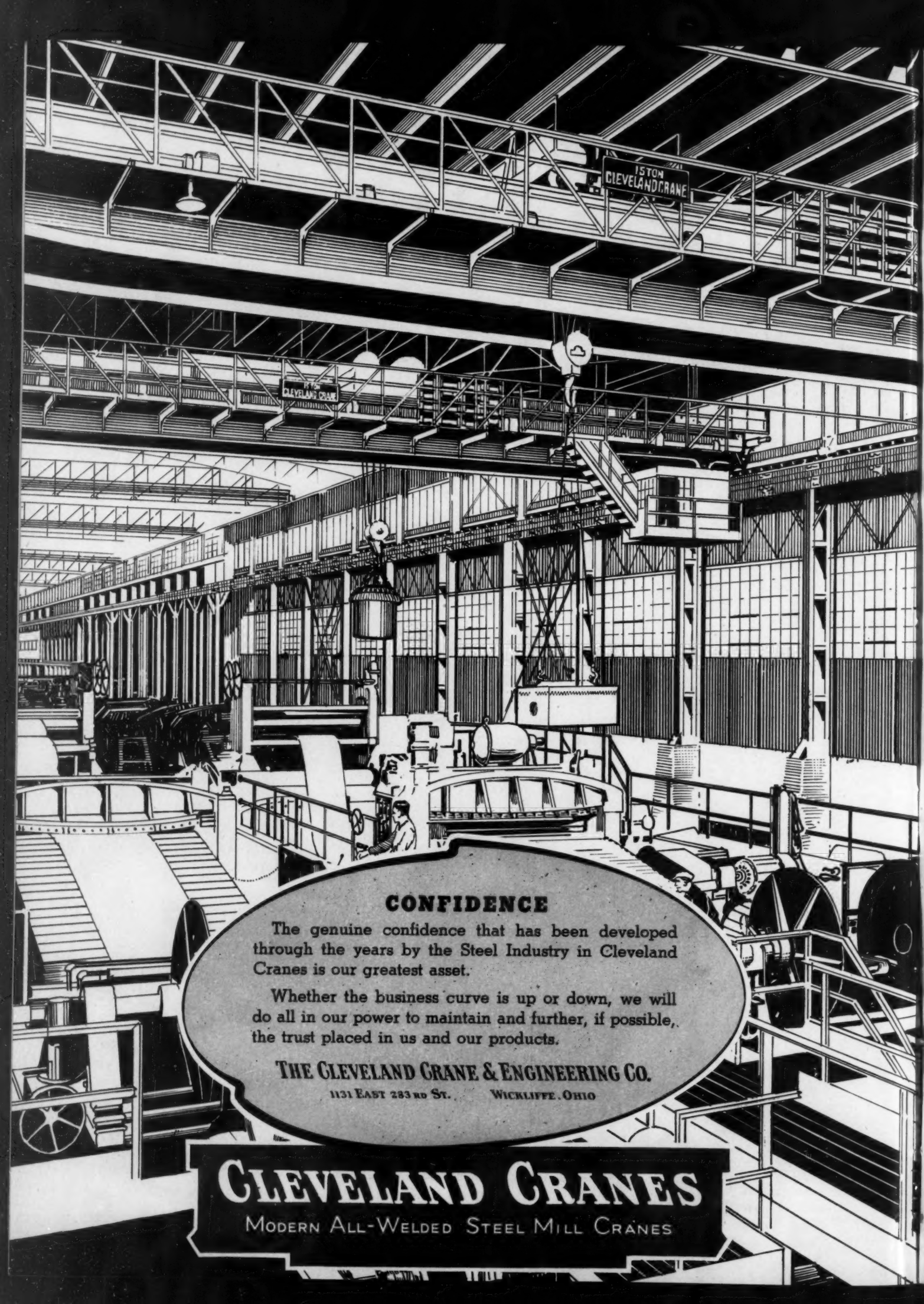

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CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

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THE merry-go-round is started again. John L. Lewis and his miners were the first to grab for the brass ring, and close behind came Philip Murray with the steelworkers, both seeking higher wages which may turn out to be really brass in view of possible resultant price increases. And just to add to the general confusion, the steelworkers have begun suits for "portal-to-portal" and "preparation-for-work" pay. The retroactive possibilities of these suits are particularly dangerous, as in many cases the amounts of money involved in retroactive claims may be so great as to throw companies into bankruptcy — but perhaps that is what some of those behind the move desire.

▲

AVERAGE hourly earnings of employees in the steel industry hit a new high in September at 136.2 cents. Wage earners worked an average of 37.5 hours per week in September, and the average number of employees was 595,700.

▲

SPIRALING wages without increased productivity are disrupting the prosperity of the country, according to Eugene G. Grace, chairman of Bethlehem Steel Company. Mr. Grace said that if there was a possibility of raising wages with present steel prices, he would rather see a reduction of steel prices for the good of the country's economy as a whole.

▲

LAST month we referred to a salesman who always keeps his hat on while working at his desk to remind him that he has no business being there. Comes a letter from B. J. Ballard, of Pittsburgh, Pennsylvania, observing that, if salesmen didn't get so many magazines, they wouldn't have to sit around the office so much to read them. Thanks for admitting that you do read them, Mr. B.

▲

ACCORDING to figures from the Federal Power Commission, total power production in the United States in 1945 amounted to more than 270 billion kwhr, of which industry consumed 143.2 billion kwhr, or 52 per cent. Of this industrial consumption, 46 billion kwhr (about 32 per cent) was generated in industrial power plants. The iron and steel industry consumed 21.7 billion kwhr, or 15 per cent of the industrial usage. Based on steel production, this means 272 kwhr per ton of ingots produced.

REPAIR and maintenance costs during 1945 jumped to a record figure of more than $542,000,000, according to the American Iron and Steel Institute. This gives a unit cost of $9.07 per ton of hot rolled iron and steel products, against $8.20 for 1944 and $6.30 in 1940. Wages represent the largest single item in these expenditures. It is believed that the figures for 1946 will also be high.

▲

DURING the first half of 1946, the automotive industry was the steel industry's top customer, consuming 10½ per cent of the finished steel. Containers were second with 9½ per cent, followed by construction with 9 per cent and rail transportation with 7½ per cent.

▲

ESTIMATES by Civilian Production Administration show steel requirements for 1947 at 63,000,000 tons of finished products, while production is gaged at only about 56,000,000 tons, representing slightly under 90 per cent operations for the industry.

▲

ELBERT HUBBARD once observed: "People who take pains never to do any more than they get paid for never get paid for any more than they do."

▲

THERE is a lot of food for thought in the case of a plant in the Pittsburgh district which installed new wire drawing equipment of the most modern type, only to have it held down to about one-quarter speed by the union operators. This indication is just one indication of the current thinking which believes the fallacy that higher real wages can be forthcoming without an increase in productivity.

▲

PRACTICALLY every major steel producer is experimenting with the use of oxygen in the open hearth, either using it to enrich the air used for combustion in the furnace, or bubbling it into the bath. Both methods have resulted in material savings in time, the first method being particularly effective during the melt-down and the second method speeding up the working of the heat. Gains of as much as 50 per cent or more in production rate have been reported.

▲

MAYBE President Truman isn't a hoodoo, but during the first half of the recent Army-Navy game while he sat in the Navy cheering section, Army pushed the Navy around unmercifully. During the second half, with Mr. Truman in the Army cheering section, Navy really beat up the Army and was not stopped until Mr. Truman left to catch his train.

▲

THE supreme court of Wisconsin recently upheld the validity of a section of that state's employment peace act which requires a three-fourths vote of a concern's employees before the firm can sign a closed shop contract with a labor union. If that will bring peace, we're for it, but we can't help wonder when we see small minorities, by picketing and similar devices, throw large industries and whole communities into an uproar.

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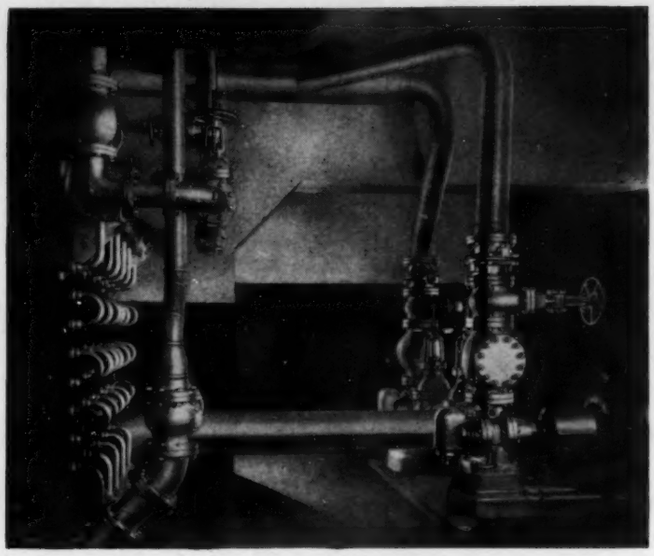

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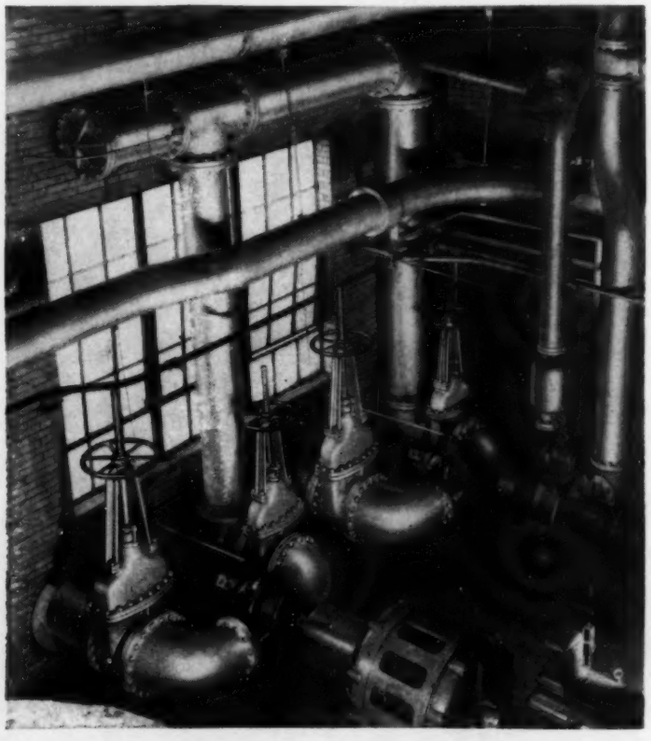
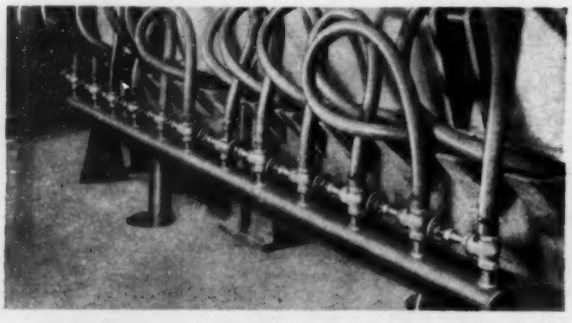


WATER LINES FOR DESCALERS *showing Crane No. 431, 150-lb. brass gate valves on fabricated header.*



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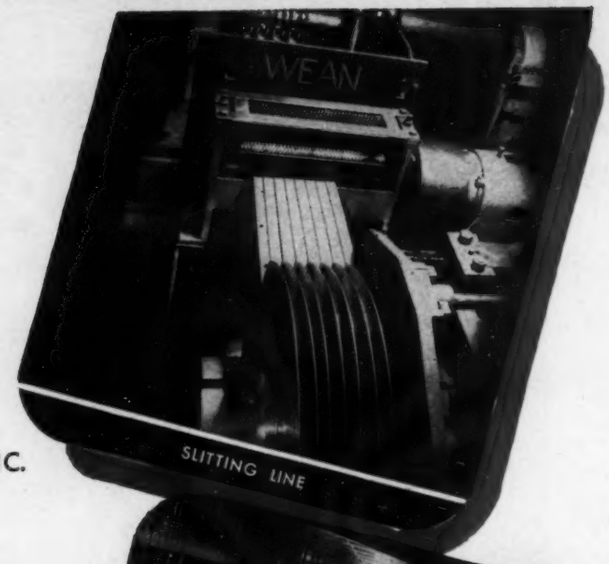

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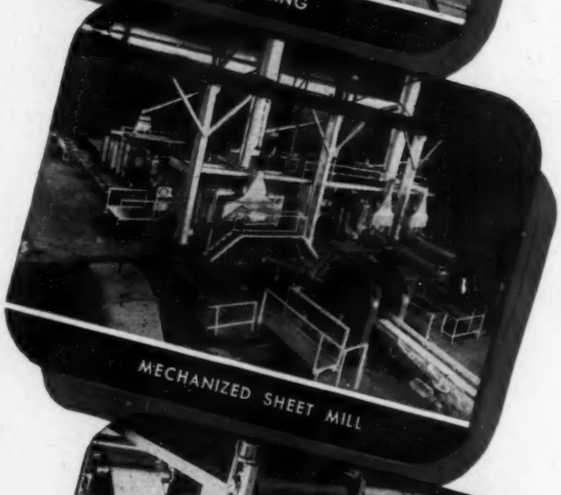
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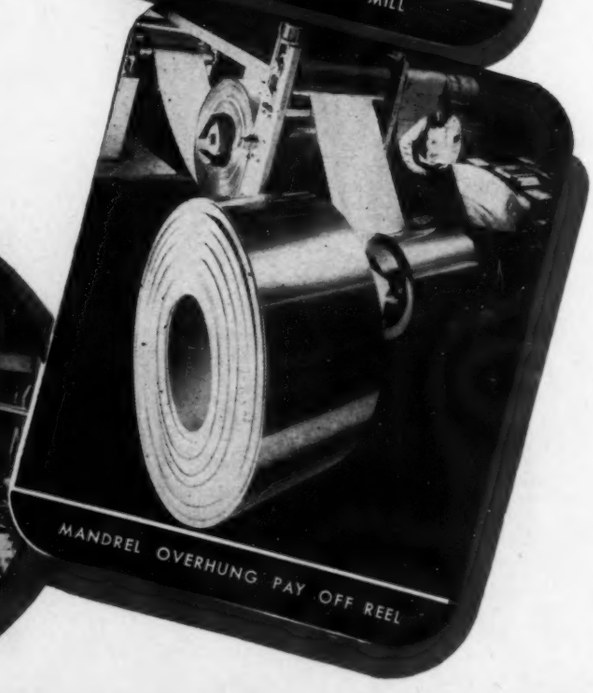
MANDREL OVERHUNG PAY OFF REEL

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Iron AND Steel ENGINEER

DECEMBER, 1946 VOL. XXIII NO. XII

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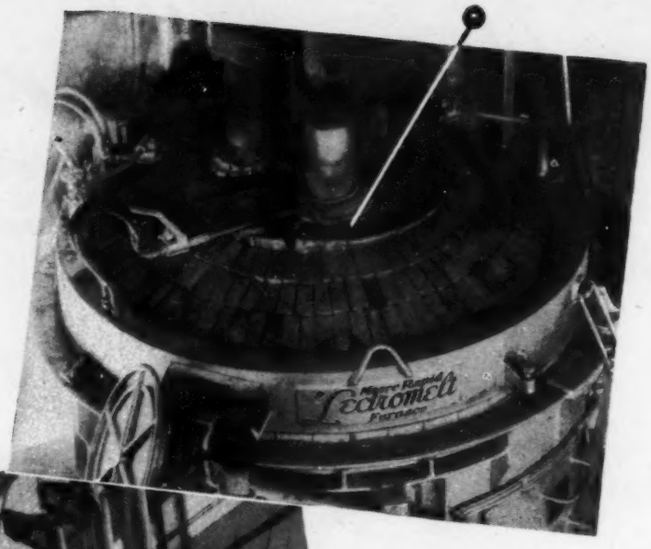
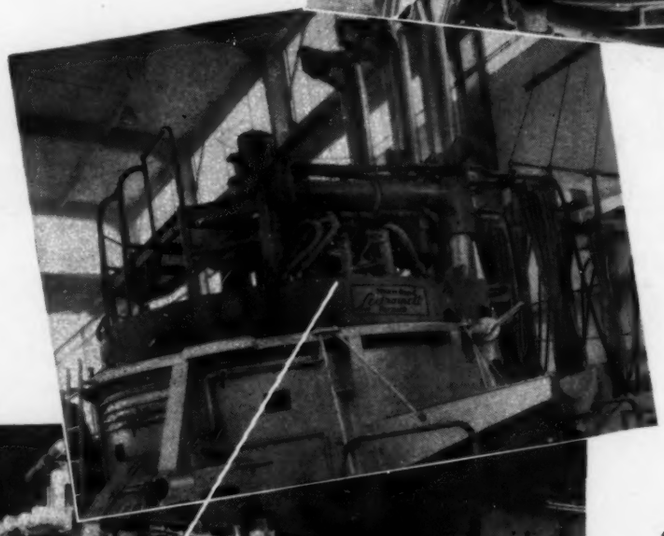


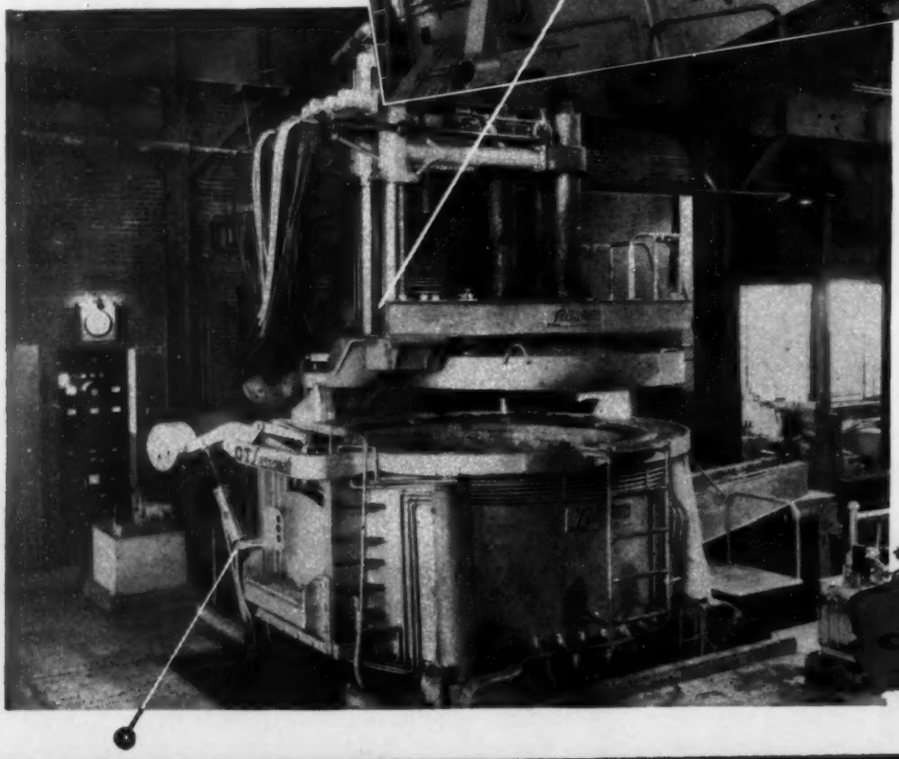
ELECTRODE CONSUMPTION

Users find that electrode consumption during operation of Lectromelt Furnaces is 14% less than with fixed roof furnaces on the same type of work. One user reports as much as one-third reduction in electrode consumption.



ROOF LIFE

Users of Lectromelt Furnaces have found that roof life with top charge furnaces is 18% longer than with door charge furnaces on similar production.



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NEW 56 IN. CONTINUOUS HOT STRIP MILL,

The Steel Company of Canada, Ltd.

. . . . describing one of the new continuous hot strip mills to be completed since the end of the war . . . .

by C. J. Porter

ELECTRICAL ENGINEER

THE STEEL COMPANY OF CANADA, LTD.

HAMILTON, ONTARIO, CANADA

▲ THE increasing demand for flat rolled steel products in Canada was such that prior to the outbreak of World War II, the Steel Company of Canada had made plans for a program of expansion in the production and processing of these products in up-to-date methods. These plans included the construction of a continuous hot strip mill with its allied finishing processes.

Figure 1 shows the general layout of the complete undertaking, consisting of slab storage yard, slab heating furnaces, reversing mill and plate finishing department, a six-stand continuous hot mill and hot finishing lines, cold reduction mills with provision for strip pickling, cleaning and annealing, sheet finishing and tinplate processing department.

The initial step in this program was the construction of the 110 in. plate mill. Dislocations of war made it advisable to postpone other projects of the plan until the end of hostilities. Construction of the plate mill started in 1940, and the mill was put into operation in April 1941. This mill has been referred to in some detail in *Iron and Steel Engineer*, April 1942. Briefly the plate mill consists of a four high 110 in. reversing mill driven by a 5000 hp, 35/80 rpm, 700 volt d-c reversing motor. A distance of 31 ft 4 in. in front of the main mill is a vertical edging mill driven by a 500 hp, 700 volt d-c, 125/406 rpm motor. About 112 feet from the edger mill is the No. 1 slab heating furnace. On the runout side of the mill and about 230 feet from the mill is a plate transfer to the plate finishing department building. During the war this mill provided large quantities of much needed plate for Canadian war time ship building.

The second stage of the project, that of the continuous hot mill, got under way in 1944 when it again became possible to obtain supplies of electrical and mechanical equipment and the large amount of construction material needed for such a project. The first equipment was placed on order in August 1944, and the first strip was rolled in the early morning of December 13th, 1945.

The continuous hot mill is a continuation of the original plate mill, the universal mill acting as the rougher for the continuous mill. The mill building is altogether 1400 ft long × 90 ft wide, served by a 50/25 ton crane, and a 25/15 ton crane. The original motor room, in which provision had been made for the electrical power supply switching and control for the complete project, was extended 200 ft to house the continuous mill main drives and auxiliaries. The motor room, is now 500 ft long and 50 ft wide and is served by a 50/25 ton crane, which crane also serves the roll shop and machine shop in the same bay. The motor room lies between the mill building and the slab yard with the slab heating furnaces at the north end. A second slab heating furnace, a duplicate of the original No. 1, is being installed to meet the demand of the continuous mill.

Linked up with the universal mill runout table at the plate transfer with a short approach table is the new six-stand 56 in. continuous hot mill, see Figure 2. Immediately ahead of No. 1 mill stand is a rotary crop shear and scale breaker. The crop shear is driven by a 75 hp constant voltage d-c motor and is manually controlled from the shear operator's desk. The approach table, hydraulic sprays, etc. are also under the control of the shear operator. The 16 × 56 in. scale breaker is driven by a 75 hp variable voltage Ward-Leonard controlled motor, and is speed matched with the first mill stand. The mill operator from the main speed pulpit, sets the required speed relationship between the scale breaker and mill speeds, and any deviation is thereafter corrected automatically. This allows the mill operator to center his attention on the performance of the main mill. High pressure water sprays automatically controlled are placed following the scale breaker and first mill stand to remove scale. The continuous mill consists of six finishing stands spaced on 18 ft centers. Each mill stand is a four high mill with work rolls

Presented before AISE Buffalo District Section Meeting, May 15, 1946

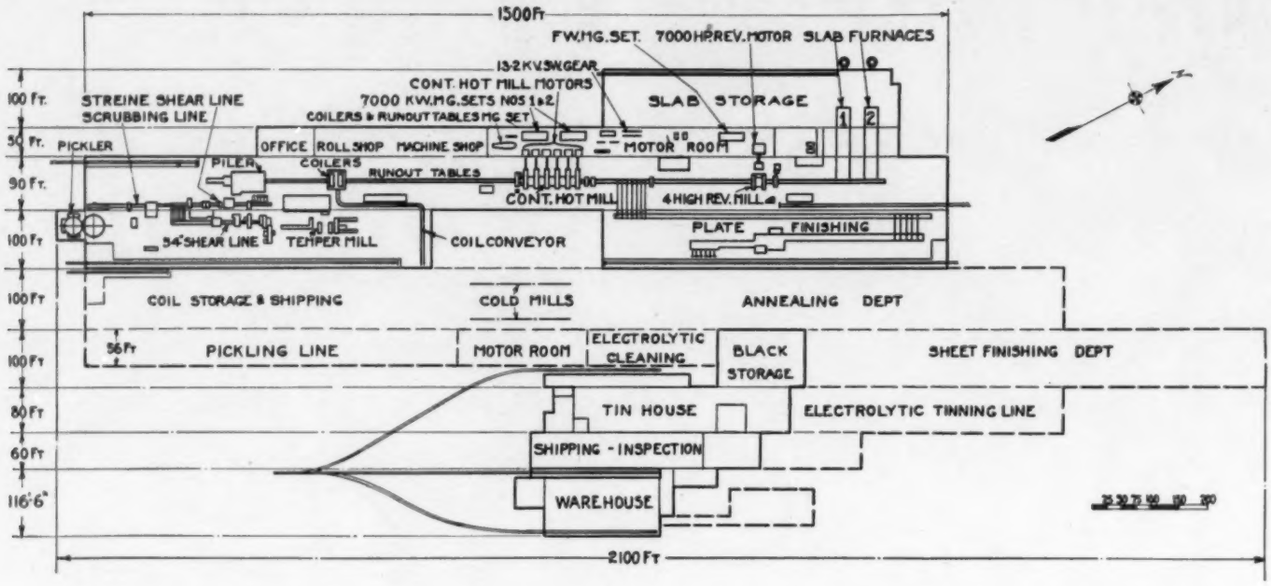


Figure 1 — Mill layout of 110 in. plate mill and 56 in. continuous hot strip mill at Steel Company of Canada, Hamilton, Ontario.

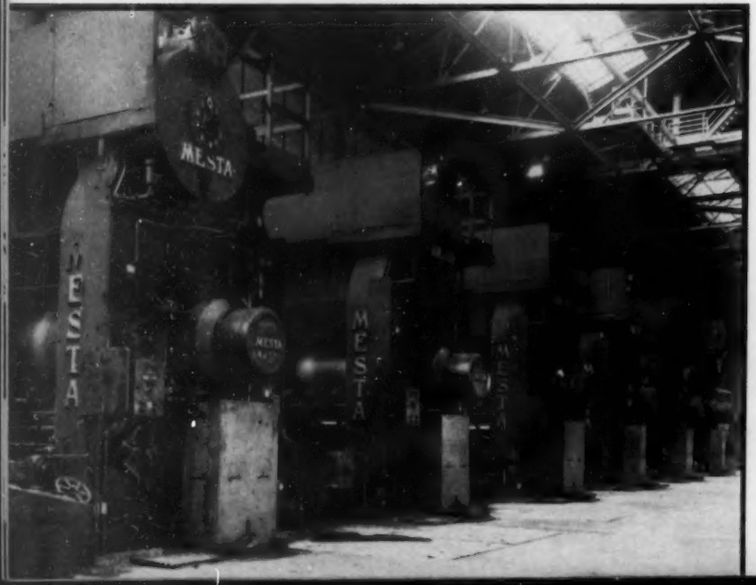
22½ in. diam × 58 in. long, and back up rolls 45 in. diam × 55 in. long. Electrically operated loopers are installed between main stands. The looper motors are driven from a special low voltage m-g (motor generator) set power supply, and are controlled from the main speed pulpit.

Horsepower, gear ratio, roll speed and strip speed in the continuous mill are as follows:

The main stand motors, see Figure 3, have conventional Ward-Leonard control, power being supplied by two 7000 kw m-g sets, shown in Figure 4. Each m-g set has two 3500 kw, 600 volt, d-c generators driven by a 9800 hp, 13,200 volt, 3 phase, 25 cycle, 95 per cent power factor, synchronous motor, at 375 rpm. These m-g sets are equipped with a high pressure oil lift system on each bearing for ease in starting up the machines after extended shut down. A separate oil system of the pressure type supplies flood lubrication to the bearings. Provision also has been made to extend this flood lubrication to the bearings of the main drive mill motors should it be desired to do so in the future.

The bearings of these main drive motors are of a new self-lubricating design. Each bearing is equipped with a solid oil ring or thrower which is pressed onto the motor shaft and runs in the bearing oil well. An oil wiper attached to the bearing cap guides the oil over the length of the bearing surface.

Figure 2 — General view of 56 in., 6-stand continuous hot mill.



Successful rolling of strip at high speed requires careful adjustment of the relative speeds of mill stand rolls. To this end, the motor driving each stand has a coarse adjustment field rheostat remotely operated from the main speed pulpit. In addition a vernier rheostat, manually operated by the operator himself, provides a means of fine adjustment of speed. The speed of the mill train as a whole may be changed by means of a motor operated potentiometer rheostat controlling the voltage of the main power bus. For accurate and stable speed characteristics of the mill, it is most desirable to hold constant voltage on the bus for any setting. This has been accomplished by means of amplidyne control of bus voltage which maintains steady voltage at the main motor armatures irrespective of load. It might

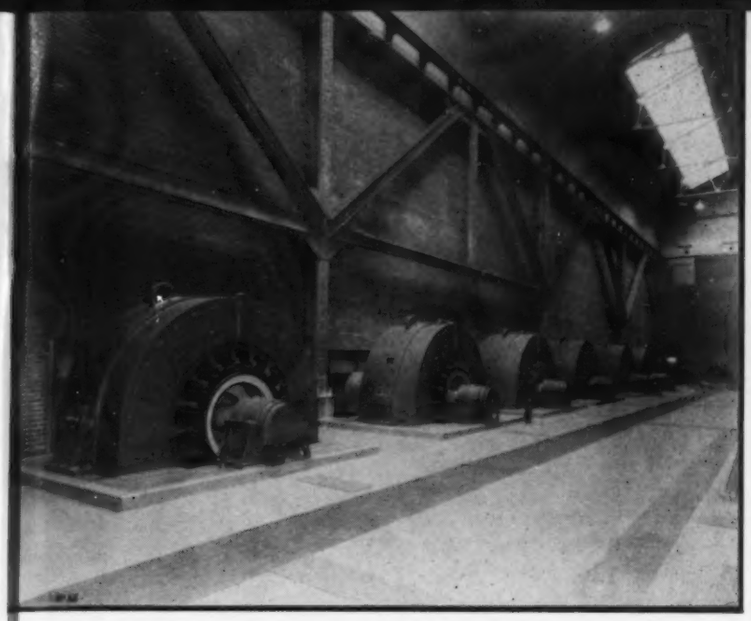


Figure 3 — Main mill motors for 56 in. mill are located in adjacent motor room, and have conventional Ward-Leonard control.

Figure 4 — Twin generators for main mill motors are 3500 kw, and are driven by a 9800 hp, synchronous motor.

here be mentioned that if future requirements demand a greater diversity of speed range between the first three and last three stands, provision has been made to split the bus into two sections each having independent voltage regulation.

The main exciter set is driven by a 500 hp, 2200 volt, 3 phase, 25 cycle synchronous motor and consists of four exciter generators. A 125 kw, 250 volt d-c exciter for the fields of the 9800 hp synchronous motors, a 125 kw general purpose exciter, a 75 kw, 500/250 volt d-c generator supplies power for the scale breaker motor and a 50 kw, 300 volt exciter for the main 3500 kw generator fields. Provision has been made for an additional 50 kw, 300 volt, generator field exciter if it is decided to split the 600 volt bus.

Figure 5 shows the 600 volt, d-c main bus and circuit breaker tunnel in the motor room basement. This tunnel is 14 ft-8 in. wide and runs between the foundations of the large motor generator sets and main stand motors. The motor generator sets were located directly opposite and in line with the motor foundations to simplify to some extent main current connections. The physical layout is such that all circuit breakers of like polarity are on the same side of the tunnel with the two main busses located behind their respective row of breakers. The connections are brought out directly from the machine terminals by the shortest possible route to give ample spacing and then drop down to the breaker studs.

The bus structure is aluminum channel supported in two directions throughout its length to withstand possible short circuit currents. Quick action trip and built in protection of the circuit breakers are also expected to minimize the effects of any short circuit overload.

The considerable heat losses of the machines in the motor room are taken care of by a down draft recirculating cooling system. The ventilating air is drawn from the motor room through the machines and down to the basement where it passes through fin type water circulated air coolers. Fans then force the cool air up into the motor room. In all 325,000 cfm fan capacity is required for the hot mill section, while 130,000 cfm is required for the reversing mill section of the motor room. Two 20,000 cfm make-up air fans bring air in from outside the mill through viscous oil traveling screen filters. These fans keep the motor room under a slight pressure and provide for such air as in bled out, to cool the auxiliary motors.

Following the No. 6 mill stand and spaced 11 ft-9 in. center to center is the flying shear. This shear is designed to crop either head end, tail end, or both, of rolled strip of lighter gauges that are to be coiled; or to cut into lengths the heavier strip to go to the piler. The flying shear itself is driven by two 150 hp, d-c motors, connected to a Ward-Leonard generator and speed matched electrically with the last mill stand. In order to properly crop the strip without excess waste material the shear must know when strip is entering or leaving a stand. To accomplish this, load relays are provided for each stand. The shear operator at the main

Figure 5 — General view of 600 volt bus and circuit breakers, which are located in a tunnel in the motor room basement.

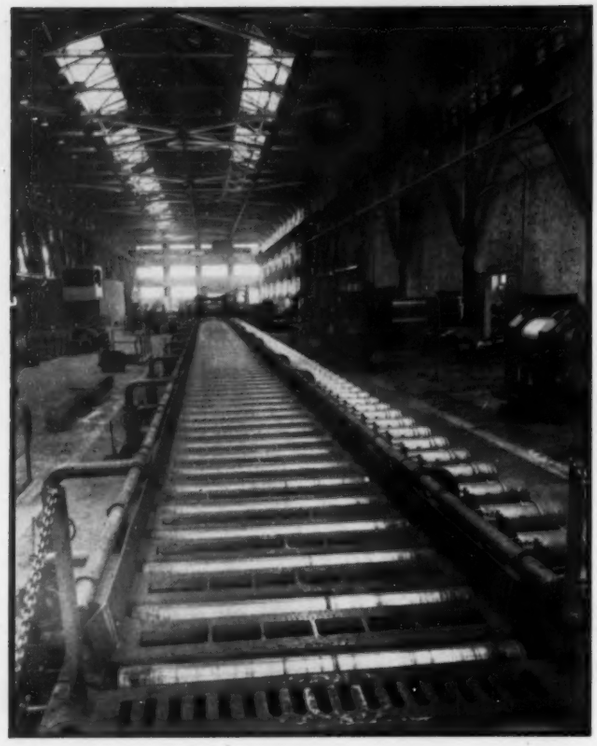


Figure 6 — The runout tables have individual motor drives.

speed pulpit selects the proper stand relay, and by means of variable time-start and time-stop adjustments is able to control the time, with respect to the progress through the mill of the strip, when the first or last cut is made by the shear. On automatic setting, the shear then starts up from rest so that the cut is actually made at the proper time. When cutting up strip into lengths, the shear is kept running and speed matched with the last stand throughout the length of the strip. The cut lengths may be varied from 30 feet maximum to 13.75 feet minimum, irrespective of the speed of the mill. The close speed matching that is required between shear and last mill stand is obtained as the result of a combination of the use of the amplidyne for the coarse tie and electronic control for the fine tie adjustment. The maximum variation in cut lengths has been found not to exceed 1¾ in. for 248 in. flats excluding the head and tail cuts.

In conjunction with the flying shear is a crop disposal equipment which is semi-automatic in operation. At the shear is a set of pinch rolls running at 25 per cent over speed. The pinch rolls are closed and timed to catch the head crop and throw it sufficiently far ahead of the strip for a gate in the table line to deflect the crop end into a pit, and which then closes after disposing of the crop and allowing the strip itself to continue along the runout. The gate itself is pneumatically operated and controlled also from the main speed pulpit. Likewise the tail crop may be sent into the pit by opening the gate in time to catch the tail crop end.

The runout tables, shown in Figure 6, are divided electrically into four sections. The first two sections extend about 300 ft to the first of two down coilers. The last two sections carry flats to the piler located 470 ft from the flying shear. In all there are 169 table rollers, individually motor driven. These motors are d-c Ward-Leonard controlled, each section having its separate Ward-Leonard generator. The power supply and control for the last two sections are so arranged that they may be transferred to the two down coilers when coiling strip. A six unit m-g set driven by a 1500 hp, 220 volt, 3 phase, 25 cycle synchronous motor supplied power for the flying shear, tables and coilers, having generator capacities as follows:

Flying shear generator	500 kw
Table section No. 1	250 kw
Table section No. 2	250 kw
Table section No. 3 or coiler No. 1	125 kw
Table section No. 4 or coiler No. 2	125 kw

Although no attempt is made to automatically speed match the table runout or coilers with the mill speed, it is most desirable to have quick and accurate pre-set manual adjustments for speed. This is obtained also by amplidyne control. The control switchboard for the flying shear and runout is on one side of the m-g set.

The operators control pulpit for mill runout tables and coilers is from the coilers pulpit which is an elevated section at one end of the temper mill substation. An unobstructed view of the mill is obtained from this position, as shown in Figure 7. It is possible to transfer the control of the first table section to the rollers control desk when the occasion demands. Also the control of table sections No. 2, No. 3 and No. 4 may be transferred to a pilers control desk when piling flats. A general view of the main speed pulpits, Figure 8, is shown looking towards the mill runout.

As the temperature of the hot slab and strip is important, optical recording pyrometers have been installed at various positions along the line, one at the discharge end of the slab heating furnace, one at the approach to the continuous mill, one at the runout end of the mill and one at the table near the coilers. Water may be sprayed on both sides of the strip as it proceeds along the runout tables for the control of strip temperature.

After reaching the piler, flats are removed to a hot bed especially designed to reduce warping of the hot

Figure 7 — The coiler control pulpit affords an unobstructed view of the mill.

flats while cooling. A Streine shear line consisting of a roller leveler, conveyor and shear with side and end cut further process the flats to finished size.

Running parallel with, and along side the hot mill bay is the hot rolled finishing building which is 600 ft long and 100 ft wide. This building has a railway track running the full length and a truck loading platform for shipping facilities. At present a 15 ton high speed crane serves this building. Also a 50 foot extension at one end houses the batch pickler.

Coils are delivered by conveyor from the coiler to the finishing department where they are stored and allowed to cool before further processing. In this building is a temper mill line and a 54 in. shearing line. The temper mill is a single stand two high mill with 27½ in. diam × 60 in. long rolls. The mill with its uncoiler and take-up reel are Ward-Leonard controlled and have automatic tension regulators between uncoiler and mill and between mill and take-up reel. The mill has a maximum runout speed of 915 rpm. The mill itself is driven by a 350 hp, d-c motor, and the reel by a 150 hp, d-c motor. The power supply is from a 400 kw motor generator set driven by a 600 hp, 2200 volt, 3 phase, 25 cycle motor.

The 54 in. shearing line is also variable voltage Ward-Leonard controlled and consists of uncoiler, side trimmers, roller leveler and Hallden flying shear. These are driven by a 5 hp, 50 hp, 50 hp, and 100 hp, d-c motors respectively. Top speed of the shearing line is 325 fpm. The Hallden flying shear is designed to handle strips up to 54 in. wide and 3/16 in. thick at a speed of 300 ft per minute. It is understood to be the largest shear of this design so far built on this continent. The shear line power supply is from a 200 kw m-g set driven by a 300 hp, 2200 volt, 3 phase, 25 cycle motor. This m-g set together with the temper mill m-g set is located in a conveniently located substation which also houses the control switchboards for these two lines.

Associated with the batch pickler at the south end

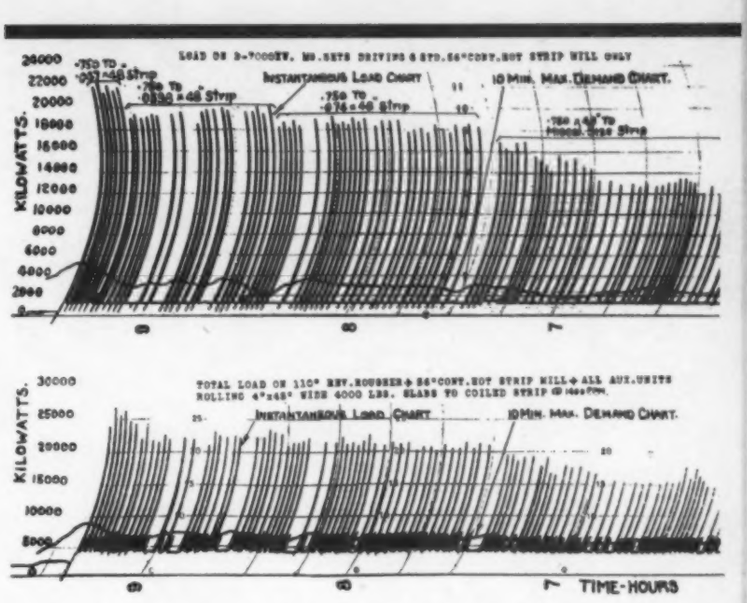


Figure 9 — The variations in the load are graphically illustrated in this chart.

of the hot mill bay is a scrubbing line for further cleaning, oiling and processing sheets.

Electrical equipment and controlling devices in a mill of this type are quite extensive. As far as possible all power and control cables were placed in underground conduits. Generally speaking all wiring subject to dampness has been installed lead covered. Multi-conductor control cable was used extensively. It may be of interest to note that for this recently installed continuous mill over 339,000 ft of various size cable was used. In terms of single conductor wire this amounts to 783,160 feet, or nearly 150 miles in length. The total length of the various sized conduit and ducts amounted to 120,500 feet and the total working time to make the installation of all electrical equipment was 133,000 man hours.

For the continuous hot mill extension only, the total a-c connected hp=25,539. A sum total of the various variable voltage Ward-Leonard controlled motors gives 201 units with a total of 22,688 hp, constant voltage d-c motors number 69 units totalling 1865 hp. The 250 volt d-c supply capacity for these auxiliaries was increased by the addition of a duplicate 1000 kw, 250 volt motor generator set.

A-c, 440 volt auxiliary motors number 140 totaling 1839 hp. As the original 1500 kva, 13,200/400 volt transformer bank has sufficient capacity to take care of this added load, no increase here was made.

A second 3000 kva, 13,200/2200 volt transformer bank has been put in service to supply 7-2200 volt a-c motors which total 4100 hp.

The secondary busses of the 2200 volt system have been kept separate as originally planned, each bus having its own grounding system for operation of ground relay protection. It was believed the reduced short circuit capacity required for the 2200 volt circuit

Figure 8 — View in main mill control pulpit.

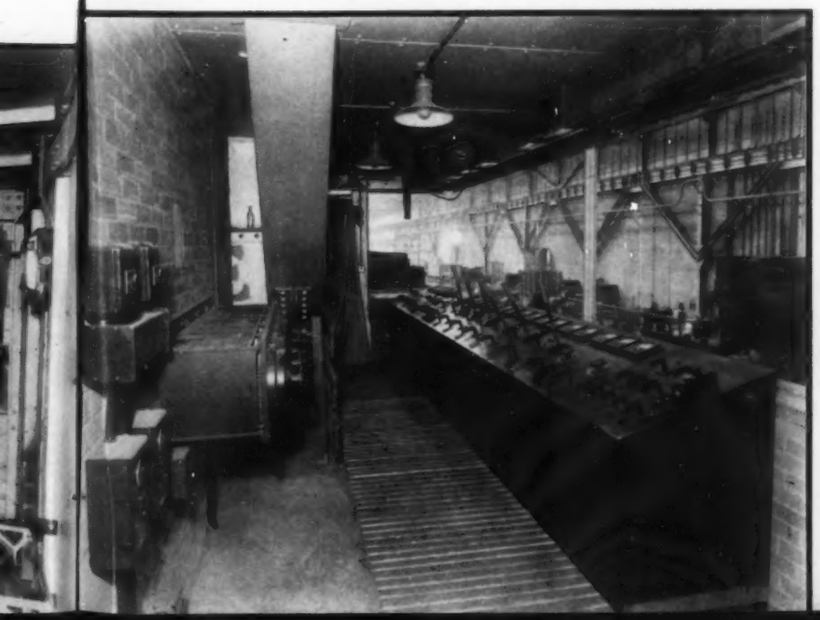


TABLE I

Stand	Motor hp	Rpm	Gear ratio	Roll speed	Fpm strip speed
1	3500	175/350	4.5:1	38.9/77.8	229 -458
2	3500	175/350	2.57:1	68.1/136.1	401 -802
3	3500	175/350	1.78:1	98.3/196.6	579 -1158
4	3500	175/350	1.404:1	124.6/249.2	734 -1468
5	3500	150/300	Direct	150 /300	883.6-1767.2
6	3000	175/350	Direct	175 /350	1031 -2062

breakers with the double bus system would outweigh the probable advantages of larger overall load capacity due to the diversity that would be expected with a common secondary bus.

High pressure water spray has been augmented by a second spray pump with its 500 hp, 2200 volt, a-c driving motor and a third unit is to be put in shortly.

Also compressed air capacity has been increased by the addition of a second air compressor unit driven by a 200 hp, 2200 volt, a-c synchronous motor.

All electric power for the strip mill is bought from the public utility at 13,200 volts, 3 phase, 25 cycle. The power factor of the mill load is automatically regulated. An amplidyne pilot exciter controls the main exciter field supplying the fields of the two 9800 hp synchronous motors, of the large m-g sets.

The 10 minute maximum demand to date of the 110 in. reversing mill and 56 in. continuous mill main drives with all auxiliaries has been 10,032 kw. This demand occurred when rolling 4 in. thick × 32 in. wide slabs weighing 3360 lb each to 0.047 × 31¾ in. strip at a runout speed of the last stand of 1500 feet per minute. Mean instantaneous power peaks were 19,000 kw at this particular time.

Electrical energy consumption of the whole strip mill including all auxiliaries when rolling several typical strip gauges are listed below.

Representative of the instantaneous load peaks and simultaneous 10 minute demand loads when rolling light gauge strips, as represented by the last item of Table II is a section of the graphic meter charts, shown in Figure 9. The upper charts being instantaneous load and simultaneous 10 minute demand load on the main m-g sets of the continuous mill. The lower charts give corresponding overall mill instantaneous and demand loads.

The third stage of the greater program which is now under consideration is the cold mill with its allied annealing and cold finishing processes. The cold mill buildings are to lie along side those for the hot mill and finishing department. An extension to the coil conveyor will bring coils from the hot mill coilers to a storage area opposite a continuous pickling line. It is expected the first mill will be a five-stand 4 high 20 in. × 53 in. × 54 in. cold reduction mill for sheets and tin plate, with provision for another future cold mill. Also to be provided are skin pass mills, radiant tube annealing furnaces, electrolytic cleaning and electrolytic tinning lines, and sheet shearing lines.

TABLE II

TOTAL ENERGY CONSUMPTION TABULATION

Slab size			Strip size		No. 6 Stand runout, fpm	Tons	Kwhr per ton	Remarks
Thickness, in.	Width, in.	Weight, lb	Thickness, in.	Width, in.				
4	37	2970	0.0478	36¾	1450	81.6	147.0	Coils
4	33	3470	0.1562	32¾	1100	81.5	58.7	Flats
4	45	4330	0.1196	48	1120	43.3	111.0	Flats
4	45	4000	0.074	48	1400	58	124.0	Coils
4	45	4000	0.0598	48	1400	52	139.0	Coils
4	45	Misc.	0.1046-0.134	48	Avg. 1125	208	115.0	Flats
4	45	Misc.	0.0598-0.074	48	Avg. 1400	116	145.0	Coils

Trends in Electrical Equipment

FOR STEEL MILLS

. . . . reviewing some of the developments in electrifying the steel industry from the turn of the century, and projecting possible progress in the future . . . .

by G. E. Stoltz

MANAGER, METAL WORKING SECTION

WESTINGHOUSE ELECTRIC CORPORATION

EAST PITTSBURGH, PENNSYLVANIA

▲ FROM the best information we can obtain, the first recorded use of electricity in the steel industry was the installation of a 2-light arc dynamo at the Edgar-Thomson Works of the Carnegie-Illinois Steel Corporation about 1882. In 1891, a 50 hp, 250 volt d-c generator and three 220 volt motors were installed in the same plant. This generator is not in operation at the present time, but in 1910 it was used as a motor to drive a line shaft in the pattern shop. This application is shown in Figure 1. It will be noted that this generator is an old bi-polar machine utilizing sufficient material to possibly build 5 or 10 motors of the same rating of present day design. The number of belts shown clearly indicate that individual motor drive at that time was something for the future. The three motors were originally installed to handle ingots in connection with the heating furnace for a blooming mill.

A record was made of the use of these motors in 1910 and it was found that all of them had been applied to other drives as follows:

1. A 25 hp, 220 volt series wound railway crane motor, No. 29, was being used to operate a soda ash hoist.
2. A 25 hp, 220 volt series wound railway crane, motor No. 3, was used to push ingots from ingot molds as shown in Figure 2.
3. A 3 hp Manchester type of motor was used to drive a grindstone and emery wheel as shown in Figure 3. This is another bi-polar motor, no doubt with a smooth wound armature connected to the driven machine by means of considerable belting.

The use of motors to drive main rolls was initiated in 1905 with the installation of two 1500 hp, 220 volt d-c motors installed to operate a light rail mill at the Edgar Thomson Works of the Carnegie-Illinois Steel Corporation. The design of these motors is illustrated in Figure 4. The starting resistance for these two motors was an assembly of light rails. These rails filled a good sized room but some 20 years ago were replaced with conventional grid resistance.

These motors are still in operation driving the same mill and no doubt giving as good service today as when they were first installed.

Another landmark in the pioneering of the use of electric drive in steel mills, particularly on main roll drives, was the installation of a 4000 hp, 100-150 rpm reversing mill motor installed in 1907 at the South Chicago Works of the Carnegie-Illinois Steel Corporation. This motor is illustrated in Figure 5. and the motor generator set supplying this reversing motor is shown in Figure 6. This equipment drives a 30 in. universal plate mill and is still in operation. It will be seen from Figure 5 that the motor utilized standard d-c generator construction prevalent at that time. It will be noted that the attendant is not as tall as the center

Figure 1 — This generator, built in 1891, was used as a motor to drive machinery in a pattern shop, and is still in use today.

Presented before AISE, Philadelphia District Section Meeting, January 5, 1946

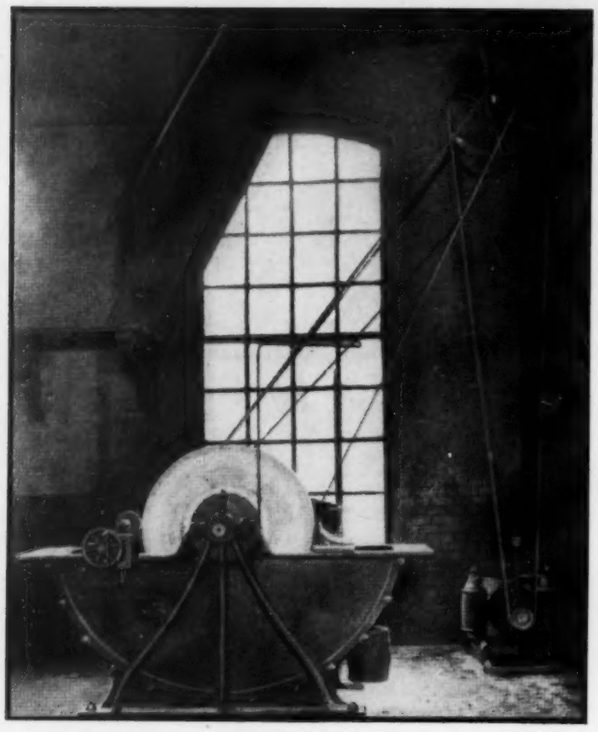


Figure 2 — Another old motor, still in use, is this old 3 hp Manchester type, shown driving an emery wheel and grindstone.

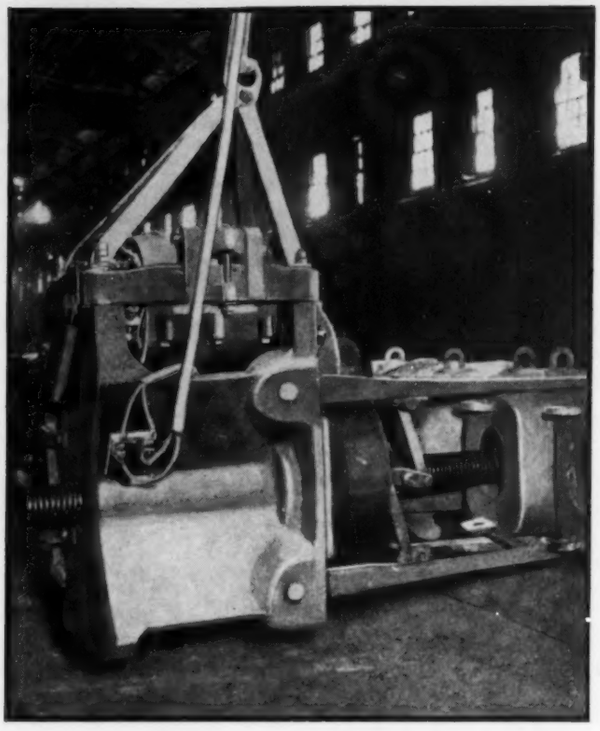


Figure 3 — The old 25 hp, 220 volt, railway crane motor shown, is driving a core pusher in a foundry.

line of the motor is above the floor line. Today we build these motors low and squatty to obtain as small a WR^2 value as possible.

Later, cascade multi-speed motors were built for main roll drives. This type of motor was superseded in 1913 by Kramer a-c adjustable speed sets which was continued in manufacture for a period of years along with two speed motors and frequency converter a-c adjustable speed main drive sets. In general, these a-c speed sets have been superseded by direct current motors on tandem mills.

The purpose in reviewing some of the very early history is to contrast this apparatus with present day equipment with which we are so familiar. The application of electrical equipment in steel mills is not static but we have been and now are in a very fast and continuously changing program of development on most lines of electrical apparatus used in this industry.

Considering present day trends, a logical place to start would be on apparatus used in the blast furnace department. In the early days, steam blowing engines were used and the excess gas was used under boilers to generate steam for steam engine driven equipment. Later, gas engines were used to not only blow the furnaces but also to utilize surplus gas to generate electric power. The present day practice is to use steam turbines to drive the turbo blowers for the furnace and to generate electric power from the surplus gas.

It is possible that some time in the future, gas jet turbines may be used for blowing blast furnaces and also for generation of electric power, but the high temperature at which gas jet turbines operate efficiently are such that the base cost of high heat resistant alloy steel and relative difficulty of machining these steels together with the rejection for quality reasons of castings and forgings make these materials very difficult and expensive.

The size of the units required for blowing blast furnaces and for generation of power is relatively large and I believe it will be some time before jet propulsion turbines will be practical for blast furnace use. The development of this type of turbine would more naturally take place where the units are smaller and where duplication of design and size will permit the development cost to be spread over a large number of machines. We believe this will take place in the aviation and possibly the generation of electric power for locomotive propulsion.

For the immediate future, we expect the trend to be for more efficient use of steam turbines for blast furnace blowing and generation of electric power rather than the adoption of the jet propelled turbine. In most steel plants there is still an opportunity to obtain more efficient performance of steam turbines as not many of our steel companies have kept up with latest practice in the use of steam turbines.

The open hearth furnace does not give the electrical engineer too much of an opportunity, although the electric arc and induction furnaces are proving to be competitors in a small way, particularly for high alloy steels. Air breakers have been developed for the electric arc furnaces to act almost as a contactor to be operated as many as 50 or 100 times a day. Special breakers have been developed for this purpose. Rotating regulators

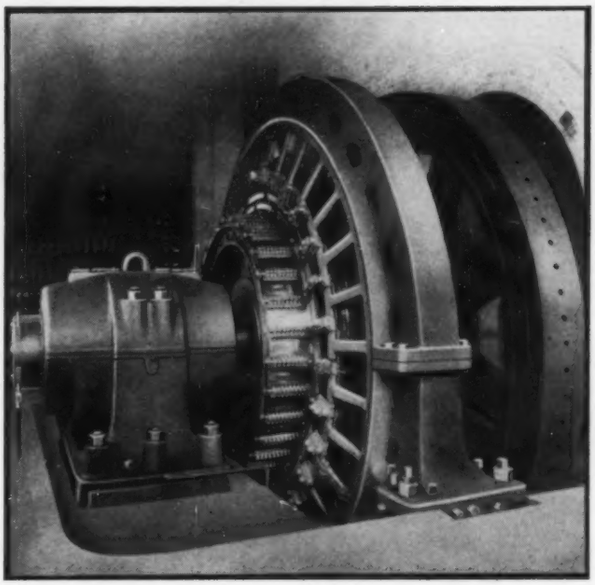
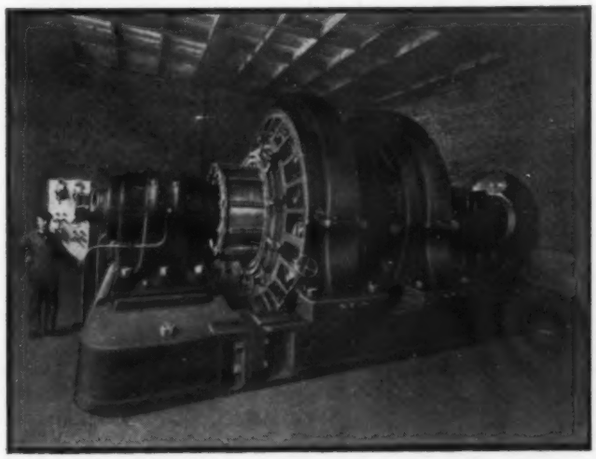


Figure 4 — The 1500 hp, 220 volt, type EM, d-c motor shown is one of two which has been driving a rail mill for over 40 years.

have displaced to some extent contactor type of regulators. The use of series capacitors is being considered to permit other loads such as lighting to be put on the same feeder without having disturbing changes in voltage. The future electrical apparatus for arc furnaces will be designed to minimize its maintenance and to control surges as well as is possible.

There is a trend towards the use of twin motor drive on blooming and slabbing mills as shown in Figure 7. The initial cost of this type of drive is substantially the same as the use of a single motor with pinion housing. The maintenance of the twin motor drive is less than that of the pinion drive due to the fact that each motor is only subject to backlash at two places, while with a pinion housing the lower roll drive will have four places where backlash can develop and the upper roll drive five.

Figure 5 — WR^2 did not worry the designers 40 years ago, as much as it would now, when they designed this 4000 hp, d-c, type EM motor to drive a 30 in. universal plate mill.



While twin motor drives have been applied to a number of large slabbing and blooming mills, we look for this type of unit to be installed on the smaller mills of this type.

The main auxiliaries of many of these mills are being driven by variable voltage equipment. This type of drive as compared to rheostatic controlled motors is smoother operating and reduces the mechanical maintenance of the auxiliaries. In addition to this, better speed control can be had.

In the future, I am quite certain that more attention will be given to manipulation between passes as there is considerable loss in time between passes on many reversing mills. There is no object in applying a large motor to a mill of this type to obtain as high a speed as possible and then waste time when the metal is being manipulated.

Early in 1944, a twin motor drive was applied to a large 4-high plate mill. The chief purpose of using this type of drive in place of a single armature and pinions was to avoid putting what is termed pinion marks on the finished plate after the gears have been worn. This

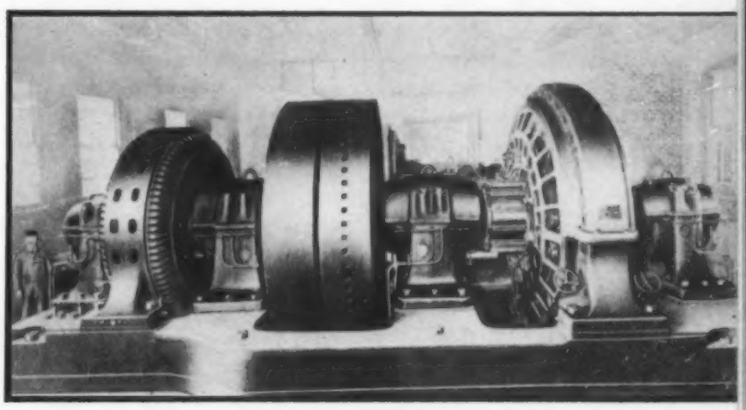


Figure 6 — This flywheel motor generator set was built to supply power to the motor shown in Figure 5.

drive has proved quite satisfactory, and there is every indication that plate mills of this type will utilize twin motor drive. It provides a smooth running mill with a minimum backlash and no tendency to mark the finished plate. This is another case where electric drive contributes to the production of an improved product.

One of the greatest advances in the production of steel in recent years is in the use of hot and cold strip mills. Figure 8 is an illustration of how tandem cold tinplate mills have increased in delivery speed. Not all mills have been shown on this curve, but the points indicate accepted delivery speed at the time these installations were made. This curve was first drawn in 1940 and the dashed-in lines, one of them horizontal and the other a continuation of the previous trend, was added indicating the possible future. The horizontal one assumed that we had reached the limit of speed and the other that future installations would continue to increase in speed at the previous rate. I have shown, two typical mills added to this curve, one installed in 1941 and the other in 1946. The heavy line represents

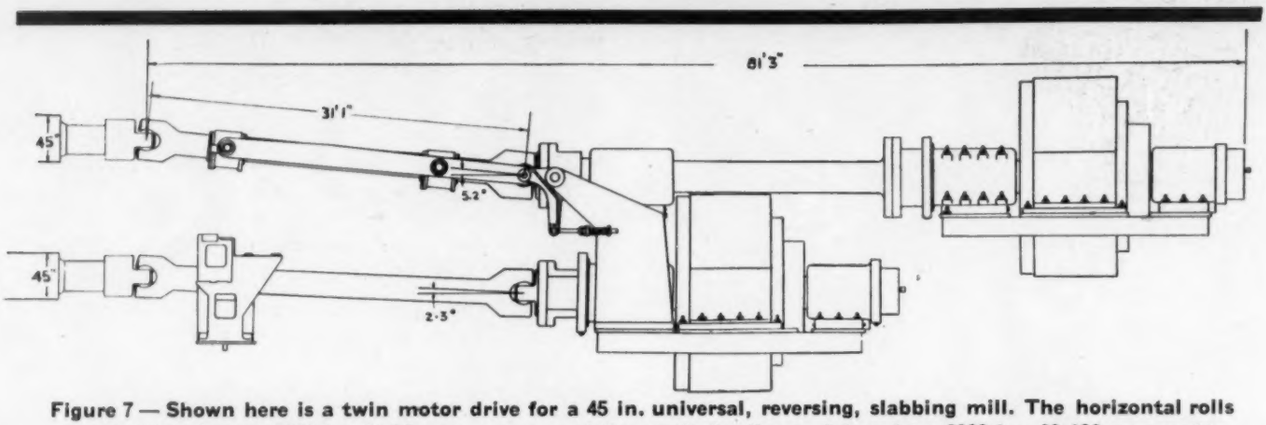


Figure 7 — Shown here is a twin motor drive for a 45 in. universal, reversing, slabbing mill. The horizontal rolls are driven by two 5000 hp, 40-80 rpm motors, and the vertical rolls are driven by a 3000 hp, 60-180 rpm motor.

the normal speed rating of these two mills, while the two points above this heavy line are the maximum possible speeds of these two mills. It will be noticed that even the normal rating of these two mills is in excess of the previous trend. Considerable care and thought is required to properly design both motors and control for these recent high speed cold tinplate mills. Long armature, small diameter motors are now built in proportions not felt possible 15 years ago.

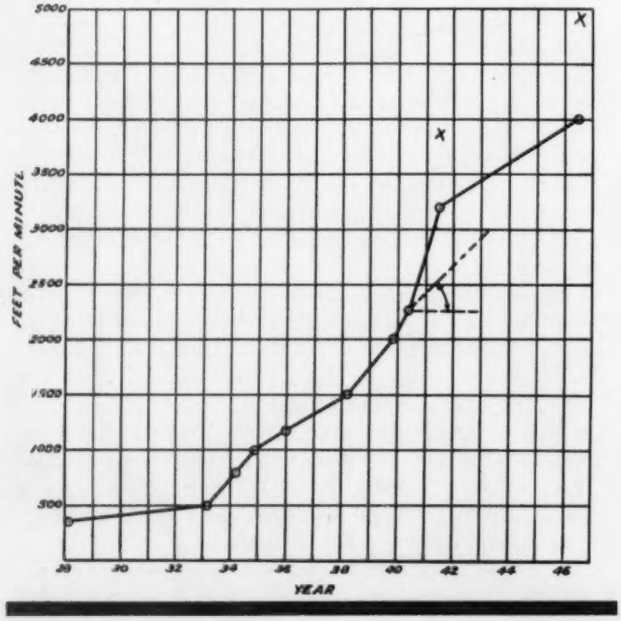
In the final stands of cold tinplate mills, the thickness of the product becomes very small and it also becomes quite brittle. It is felt that it will be important to have the work rolls operating at the same speed at all times, whether the metal is in the rolls or not. This now requires exact grinding to size. Recent mills are being designed for twin motor drive for driving the finishing stands, as illustrated in Figure 9.

On blooming and slabbing mills, the driving spindles are operated at an angle but on a high speed mill such as a tandem cold strip mill it is felt that the spindles should be horizontal. To accomplish this, it was necessary to have offsetting gears so that there is sufficient room for the driving shaft of the rear motor to pass the frame of the front motor.

The separate motors will accommodate their speeds to the diameter of the working rolls at all times.

It is quite possible the tandem method of rolling steel now used for strip will be more generally adopted for rolling of hot metal. While this is done to some extent on rod mills, tandem arrangement of stands may become more prevalent with individual motor drive. When this is done, it will be necessary to very carefully design the motors particularly in regard to their speed regulation. This not only applies to gradual changes of load but also to the transient drop in speed the instant metal enters the stand. At that time, the motor is drawing armature current sufficient to develop friction load torque. The instant metal is introduced it may be necessary to develop full load torque. Time is required for the armature current to change from friction load to full load. During this period, this increase in torque can only be produced by the flywheel effect of the motor and other rotating parts, while it is dropping in speed. This change in speed and armature current is illustrated in Figure 10.

Figure 8 — The slope of the curve, which gives average practice in rolling speeds, illustrates that speeds in cold rolling will increase for some time to come.



The abscissa is in "seconds," from zero to 1.4 cycles. It is assumed in this particular case that the friction load of the motor driving the stand idle, is about 15 per cent of the capacity of the motor. The lower ordinate scale is per cent of full load current of the full load rating. The top scale is the speed of the motor, and the scale runs from 99 per cent to 100 per cent, so in this case this transient drop has only amounted to one per cent of the normal speed of the motor.

To illustrate further, let us assume that a given stand is running idle, and that the metal coming through from the furnace is going from stand to stand until it comes to this particular stand, with the motor drawing 15 per cent of load current. In the latter part of the mill, the time for the load to build up, that is, the time from the instant the metal first enters the bite of the roll, until it is in the center of the roll, is a very small fraction of a second. Back at the early part of the rod mill it may be as much as two-tenths of a second, but in general at

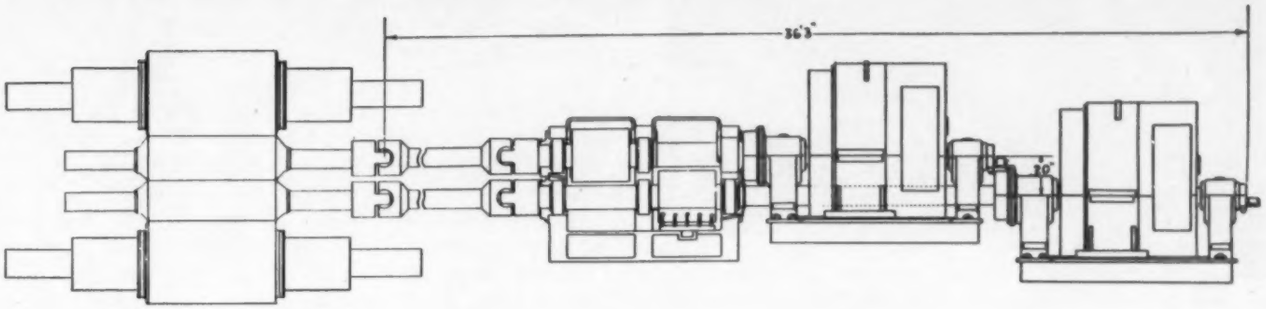


Figure 9 — Two 1500 hp, 200-450 rpm motors are used in the twin drive for the third stand of a 4-stand, 56 in. tandem, cold sheet mill.

the delivery end you can assume that the time to build up the load is instantaneous.

Now something has to produce full load torque the instant the metal is in the rolls. The armature is only drawing 15 per cent current, and in this case it takes about two-tenths of a second for the current to build up to one hundred per cent load, so, during that period the only thing that can produce the remaining torque is the flywheel effect of the motor and the driven equipment. The motor starts to drop in speed as shown by this curve. At the same time the current increases to its one hundred per cent value at which time the motor begins to recover its normal speed. It will be noted the speed rises a little above 100 per cent, and then swings back. In some mills it is desired that the mill return to the nominal speed of one hundred per cent; in others, it is satisfactory to drop down some and then stabilize it. That presents quite a problem of regulation, and I believe if it is satisfactorily solved, there will be a number of installations of hot mills that will be equipped with individual drives, which makes for a more flexible mill than if a group of stands are driven from one lay shaft and one motor.

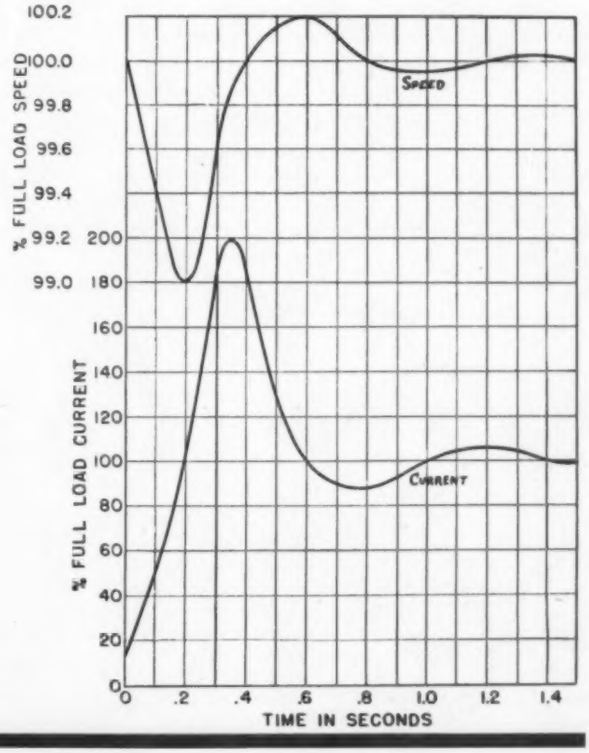
It seems as though the steel industry is either developing reversing motors for large mills, high speed motors for tandem cold and hot strip mills, or some other equally involved equipment. I believe this is a problem that will be immediately before us and will be receiving a lot of attention in the next few years.

On a hot strip mill where there is considerable distance between stands and flat product is rolled, this transient drop may be of some advantage, but on a closely coupled rod mill or tube reducing mill the effect on the metal may be serious. Naturally, the integrated transient drop should be as little as possible which means that the motor should have as small a reactance and resistance drop as possible and a reasonable flywheel effect. This type of drive may be extended to other mills rolling hot metal, particularly those rolling considerable tonnage of a few products. On merchant mills, rolling a large number of shapes, such a mill would not be of too great advantage.

A review of apparatus itself for steel mills indicates that the trend in transformers is to unit substations where the units are not so large. For outdoor service, either oil or non-flammable liquid is used for cooling. The function of transformation, regulation, protection, control and metering of electric power which has heretofore been performed by separate pieces of apparatus in an outdoor open type of substation have been combined into a single completely enclosed unit as shown in Figure 11. These units are built up to 4000 kva and for high voltages of 69 kv.

For indoor service there are two trends one is to use air cooled transformers alone and the other is to incorporate these transformers into a load center. Indoor transformers cooled by natural circulation of air through a winding with major insulation of glass, porcelain and mica is very largely fire and explosion proof. Air cooled transformers are built up to 2000 kva single phase and 3750 kva three phase and for a high voltage of 15 kv. Higher capacities can be obtained by means of auto-

Figure 10 — The graph shows the magnitude of motor transients as the metal enters a tandem, rod mill stand.



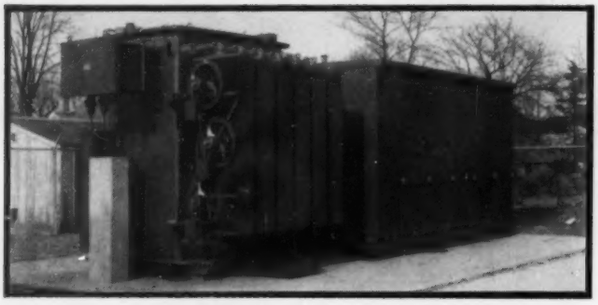


Figure 11 — This 13,200 volt to 4160 volt unit substation consisting of a 3-phase transformer, and necessary metal enclosed switchgear and relay equipment, is rated 3000 kva without artificial ventilation, and 3900 kva with air blast.

matic air blast equipment. The load centers are equipped with all protective equipment as outlined above on the outdoor units.

I think future trends will be towards unit substations and load centers and also to the use of air cooled transformers. In addition to this, there will be a tendency to use iron with still less loss than at present, which will reduce the materials required resulting in less weight.

Large direct current rolling mill motors are either used on reversing mills or to drive tandem mills. They are being worked to a point where the machines must be compensated and the tandem motors carefully designed for speed control. They are more and more becoming tailor-made for the particular application.

General purpose motors develop horsepower and are largely taken care of by synchronous and squirrel-cage motors, while direct current motors usually have to be fitted into some process, such as a reversing mill or tandem operation.

Motor generator sets have been used quite extensively by the steel industry in spite of the better efficiency of rotary converters. The steel industry has preferred motor generator sets, very largely because of better operating performance and greater reliability, penalizing themselves somewhat on efficiency, and often using power factor correction. Recently, mercury arc rectifiers have been used in place of motor generator sets. This trend should continue as the rectifier is an efficient piece of equipment.

The solder seal and the ignitron type of rectifier are the features which led to the present day acceptance of the rectifier and the installation of millions of kw capacity during the recent war. The rectifier along with electronic tubes should have an important future, since they are new and subject to considerable development. I do not believe the motor generator set has the same possibilities.

Control contactors for high current valves are decreasing in overall percentage as variable voltage is being used for these applications, and control is being mainly applied to processing lines where speed, tension or loop regulation is required with either rotating or electronic regulators.

It is quite possible that rotating regulators with variable voltage will replace relays and contactors to a very great extent. The majority of the control is factory assembled requiring as little field work during the installation as possible.

Switchgear apparatus of the metal clad type is becoming factory assembled to a greater degree. Air breakers are also replacing oil breakers in the medium voltage classes.

There are a number of new applications being considered in the steel industry, one of them is radio communication for railway switching. This will involve a short wave radio broadcasting station in the dispatcher's office that will speak directly with the engineers who will have radio receiving and sending equipment on the locomotive.

In general, electrical equipment is becoming more of a factor in the various processes of manufacture of steel. In many instances, instead of just providing power, the electrical apparatus is woven into the process to a point where it is guiding and controlling the detail adjustments of the process being performed.

If new processes are proposed it is often necessary to develop new apparatus or new combinations of equipment. There are instances where the adoption of new characteristics in the electrical apparatus will be the means of starting new processes of manufacture.

Aside from this, the general trend is to make the electrical equipment so that it requires less maintenance and reduces the interruption of service as much as possible.

DISCUSSION

PRESENTED BY

F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

W. A. SMILEY, Electrical Department, Bethlehem Steel Company, Steelton, Pennsylvania

L. J. GOULD, Assistant Chief Engineer of Construction, Bethlehem Steel Company, Bethlehem, Pennsylvania

J. DEIMLER, Electrical Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania

L. V. BLACK, Superintendent, Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

M. B. ANTRIM, Electrical Engineer, Lukens Steel Company, Coatesville, Pennsylvania

LOUIS MOSES, Superintendent, Rail Mill and Roll Departments, Bethlehem Steel Company, Sparrows Point, Maryland

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

G. E. STOLTZ, Manager, Metal Working Section, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

F. C. Schoen: We have a few of the old time motors at the plant and it is surprising what you can get out of them. We didn't realize until recently, when it became necessary to replace one of the old motors with a present day unit, just how much work they would deliver. I am wondering if some of today's equipment is mis-rated or if we were entirely off the beam on the original installation, in other words, were we, on the

old motors, getting a lot more horsepower than we thought we were paying for?

We have all had help from the more modern insulations when rewinding and reinsulating old equipment which permit in some cases, increased horsepower, and in most cases better operation.

The statements covering the decreasing use of large contactors, some by improved methods of control decreasing necessity for heavy current equipment is naturally going to help in reducing maintenance costs. The last few years most of us have been troubled with electricians whose education was mainly wiring houses, and we have suffered accordingly when they were repairing equipment. It would appear that these developments call for more skillful, better trained electricians, but certainly it will reduce the total number now necessary for maintenance.

W. A. Smiley: There is a trend which has been brought out which I consider significant and deserving of emphasis; that is, the trend to get away from heavy reciprocating mechanical devices, be they steam engines or heavy contactors, or expressed in another way, to get away from devices in which impact and vibration determine maintenance cost.

Attention has been called to the space limitations of control boards. Where heavy contactors can be replaced by relays, control equipment requires much less space. With more use made of dynamic control devices, vacuum tubes, and various types of mercury-gas tubes, we may expect our controls to be longer lived and to require less maintenance.

L. J. Gould: One question occurs to me on the dropping speed in the mill. A multitude of motors are being put on the rod mills all over the country, which gradually go from three or four to maybe eight or ten drives; but a good many of them have two or three or even four strands, and I understand one is being considered with six strands in it.

Now if we could keep some strands in the mill and keep the power used up to one-half the maximum, what is going to be our greatest fluctuation of speed?

J. Deimler: The thought occurred to me that we have, by means of rectifiers, eliminated heavy rotating motor generator sets, and now we talk of installing variable voltage drive using rotating machinery. I am just speculating a bit — what part, if any, might rectifiers have in variable voltage control?

L. V. Black: The following thoughts should be given serious consideration in any future design trend. Advertising literature as well as a number of write-ups in trade magazines would lead you to believe that with the new silicones and other improved materials, a much better motor or piece of electrical apparatus can be manufactured in a much smaller frame size and at less cost to the customer. In fact several weeks ago I received a proposal for, I believe, a 30 hp motor to be supplied in a 10 hp frame size; speed, voltage and frequency were to be identical. No doubt it would have started and run, but the question is, how long?

We now have had several years experience with the new NEMA vest-pocket edition of the formerly substantial mill type motors. Up to the rated horsepower, you can expect service without too many burnouts, but notice how sharply the dependability curve drops off if they are put in heavy duty steel mill service, where the normal complement of overloads are encountered.

I understand there is another school of thought; that is, with the advanced knowledge of insulations and various types of metals, a mill can be built like the one-horse shay. All the electrical equipment will last, let us say 15 years, the next day all equipment will have to be renewed. Isn't that a fine nightmare to have hanging over your head? That sort of business may be all right for the automobile industry where every several years you want to throw your old car away, but it has no place in the iron and steel industry.

This question of streamlining electrical equipment to suit some machine tool designer's whims, or to reduce overall first cost, is not sound business. Who cares about breakdowns, delays, and high maintenance costs, the machine representative? No, he sold the unit and forgot it. The electrical manufacturer? No, they get more and more business on replacing parts. The customer? Yes, he is vitally interested in purchasing a good trouble-free piece of equipment that will keep producing without excessive maintenance costs.

We welcome these new and higher grade materials used in the manufacture of electrical apparatus, but only if present current carrying sizes, and mechanical sizes are maintained, for then we know we will get a better product. If on the other hand wire sizes are reduced, and housings are made smaller because the newer insulations can withstand more heat, then the results are going to be extremely questionable.

M. B. Antrim: It would seem to me that we in the steel industry have quite a job ahead of us to assimilate some of these new improvements. I am probably rather prejudiced on this matter. As a member of the maintenance department, I believe that any education should in large part take place in the operating department, because of course the maintenance men must know how a machine works or they couldn't fix it in the first place. There is no doubt however that we must engage in a large amount of education in order to be able to economically and profitably use these new developments, and we certainly hope they will very soon be taking place in the industry.

Louis Moses: With regard to acceleration and deceleration of reversing mills, I suppose many of us here are familiar with a blooming mill now driven with a cross-compound steam engine and having an enviable record on production by volume, as well as the number of ingots per hour. It is understood that a standing order is afforded to any electrical concern to furnish the otherwise advantageous motor drive with the provision, however, that similar or bettered characteristics of quick reversals are attained.

Mr. Gould commented on the strategic distribution of motor drives along the train of tandem continuous rod mills. This involves a number of considerations which the designer of the drives must keep in mind. Various combinations of multiple drives are in successful operation with the tendency present of increasing the number of motors on new mills.

The high cost of installation of such drives having voltage control is an important consideration. Reasons for such equipment must be good ones, because there are many successful single-motor mills, having all stands driven from a common line shaft, doing a good

job with respect to section, yield and costs, and to some degree in the production of quality rod.

However, these mills do not offer full possibilities of product size range. More important is the yield phase which is tied in with awkwardness and expense of keeping rolls and mill settings to requisite diameter, relative to the train as a whole and the close adjustments necessary. It also becomes a problem to economically produce the high grade products demanding a fine surface. Even with the broken-up drive, the latter offers many problems notwithstanding the better control of the bar.

We do not know too much about what actually occurs to the bar in its reduction by the roll passes, as simultaneously worked on throughout its length. There are many variables which must be handled by the roller on geared mills solely by roll settings. The one vital requisite of an operation is to produce a coil with the very least amount of overfill on the back end which must be cut away as scrap. It will be understood that a rod mill is generally and almost always run with a very slight amount of pull on the bar between each stand to prevent cobbling. There are so many variables during a day's operation, that even if a roller could set his mill to an ideal of no push or no pull, it would be for a short time only and such things as billet temperature, grade changes, etc., would most likely cause a cobble. A slight push would be advantageous from the standpoint of each individual set of rolls, thereby acting independently of any other, but this would be dangerous practice and a slight pull is demonstrated over many years as being best. There is a penalty attached because the yield is affected. As the back end of the bar successively leaves the respective stands, the pull between stands is cumulatively released with the overfilled end finned. The length of the defective portion of rod is the measure of the roller's skill as well as the correctness of the roll design.

Multiple variable speed drives along the train gives a solution to such occurrances and provides means by which the pull is regulated, as has been demonstrated, so that there is practically no scrap at the back end of the coil.

Some mills, while having a very considerable advantage with multiple drives, nevertheless have incorporated in the train groupings as many as six stands which are driven from one of the motors. Considerable power is required to drive this group of stands, all driven from a common shaft, but speed control is no less vital at this position near the roughing end of the mill. The tendency is to install a motor for each pair of stands, and by such means have a much more delicate control as compared with groupings and loads such as above.

Stranding is commonly double, there are a number of mills rolling three strands and four stranding is accomplished. It is thought in some informed circles that six strands can be successfully rolled through a tandem mill. Speed control is affected because, frequently during the day, interruptions occur and at times only one or two strands are being rolled, immediately followed by introduction of full capacity with its abruptly increased load.

It is expected that improvements over the already excellent drives and controlling equipment will be forthcoming even to the extent of having built into them a mill man's desire of ranges beyond the specifications. Some years ago I commented on a paper by Mr. Stoltz, by mentioning how operators will change roll diameters to obtain an increased roll life, and thereby throw out of the window all of the engineer's calculations and engineering on torque requirements. On a rod mill it became desirable to roll something requiring a lowered speed of the group of finishing stands. In doing so, the voltage drop of the motor generator set interfered with power requirements of the roughing and intermediate groups of stands. So that a safe prediction is that whatever equipment may be supplied to a steel mill, the engineer may be sure that it will be overloaded, stretched and worked to its utmost limit as often as not beyond original specifications.

L. F. Coffin: In discussing changing standards, care should be exercised to relate the differences in overload capacities.

In buying a 20,000 kw turbine, you may get one that has an overload capacity of 110 per cent or one with 125 per cent. They are still both 20,000 kw machines, but will do radically different jobs. Hence the electrical engineer and mechanical engineer, in applying these new standards, should be careful to see that the mechanical and electrical characteristics of the equipment are properly combined and synchronized. Of course, it is a fact that mechanical maintenance in mills in dollars per ton, is greatly in excess of electrical maintenance, so that by and large all electrical applications should bear this in mind, so that smoother acceleration and deceleration (even at a higher first-cost) might be secured. Starting and stopping load concentrations on mechanical equipment frequently do more damage than slowly applied extreme overloads.

G. E. Stoltz: I would like to first discuss the question in regard to rectifiers versus the use of motor generator sets. It was my purpose to leave the impression that rectifiers will displace motor generator sets that are used for the generation of power, such as 250 volts for shop circuits, not necessarily connected with any particular mill drive.

The question is asked, will rectifiers be used on variable voltage? There are what are termed mototroller units where a small direct current motor is used with its rectifier, the whole, constituting a variable voltage equipment. Many large variable voltage equipments, such as used on blooming mills or cold tandem mill drives require regenerative braking, and the reversing blooming mills also require frequent reversals. On such applications motor generators are used.

A rectifier is good today for passage of power in one direction and is not equipped to absorb the power that is regenerated when the motor or mill is reversed. Two rectifiers can be installed, one to act in supplying power to the motor and the other used to absorb the power on regeneration, but that is a very expensive installation, and today it is our practice to use motor generator sets because of their ability to absorb regenerative power.

There are variable voltage installations such as a hot strip mill where there is no regenerative braking and little starting and stopping, and what starting there is is light load. On such applications rectifiers may be used.

Mr. Burr asked about decrease in manipulation. I did not have in mind any necessary improvement in the

electric equipment to accomplish more rapid reversals on blooming mills or mills of that type. The point I wanted to make is that attention will have to be given to manipulation. If you have watched a blooming mill that rolls a 4 × 6 in. section, it is often found that considerable time is lost in turning the piece on its side. Someone mentioned that we are getting into the crystal-gazing stage on complicated equipment. That is what the steel industry is coming to. I don't know of any industry where electrical equipment is so woven into complicated processes as in the steel industry, and we might as well face that fact.

I remember a talk given by Mr. Biggert some years ago in Pittsburgh, when he described what I believe is the first 4-high hot mill installed in this country, at Butler, Pennsylvania. You could not help but be impressed with the careful manufacture required, and the same small tolerances permitted at that time, when they used roller bearings.

This type of mill was a real workmanship-like job. I remember that someone made the statement that skilled maintenance would be required. His answer was: "The day of the monkey wrench machinist in the steel industry is over." I believe that electrical maintenance will become more complicated as new equipments are installed.

Mr. Moses asked a very good question about comparison of electrical reversing equipment for blooming mills with steam engines in the time of reversing. I well remember Mr. Pauley telling members of the Association of Iron and Steel Engineers, that you would never be able to reverse a motor as fast as a steam engine.

Reversing motor design has reached the stage where they can reverse as rapidly as a large steam engine, and at the same time develop greater torque than the engine.

Mr. Gould and Mr. Moses asked about the application of motors to rod mills. I would like to remind you that I said the application of motors to some rod and hot mills are a matter of the future. Many rod mills are now driven by individual motors. Transient drop is present and is handled in a manner, but I do think there are going to be improvements in this particular operation.

Mr. Gould asked to what extent the transient drop can be reduced. While the maximum drop in speed is important, the integrated reduction in speed must also be considered.

There are a number of things that can be done to decrease the integrated drop in speed of a motor. Let us assume a 250 horsepower motor would be required normally for a given stand, and if you multiplied the per cent average transient drop by the time in seconds, you obtained a product of three.

Now, if we were to put not a 250 horsepower motor on the stand but a 500 hp, instead of it taking full load, it would only take half a load. It would drop less and have more flywheel effect so that a material reduction in transient speed drop would result.

Mr. Moses brought up a very good question that is a good warning, and that is that maybe we could operate successfully with one strand but get into difficulty with four or possibly six strands. That complicates the problem in one way, and makes it easier in another. If there are a number of strands in the mill and a new one being threaded through the mill, naturally those in the mill may be disturbed.

On the contrary, the advantage of having several strands is that the transient drop is proportionally reduced. Regardless of whether there is one strand in the mill or several, some value of discrepancy in speed must be determined as not detrimental to successful operation of the mill, and then driving equipment selected to keep the speed within the tolerances required.

AISE
DISTRICT SECTION MEETINGS

BIRMINGHAM — **January 27, 1947**

"Personnel Selection and Job Training" by W. J. McGLOTHLIN, Education Relations Staff; Tennessee Valley Authority, Knoxville, Tennessee.

BUFFALO — **January 14, 1947**

"Recent Developments in Refractories" by H. M. KRANER, Research Section, Bethlehem Steel Company, Bethlehem, Pennsylvania

CHICAGO — **January 7, 1947**

"Radio Communications for Steel Mill Yard Switching"

CLEVELAND — **January 20, 1947**

"Electronic Communications in the Steel and Mining Industries" by W. P. PLACE, Farmers Engineering and Manufacturing Company, Pittsburgh, Pennsylvania.

DETROIT — **January 14, 1947**

"Heating and Rolling of Sheet Steel" by N. E. ROTHENTHALER, Metallurgist, Ford Motor Company, Dearborn, Michigan.

PHILADELPHIA — **January 4, 1947**

"Relation of the Modern Steel Plant to its Electrical Power Load" by A. D. HOWRY, Electrical Superintendent, Alan Wood Steel Company, Conshohocken, Pennsylvania.

"Relation of the Electrical Power Load to the Steel Plant, Steam and Fuel Balances" by H. L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.

PITTSBURGH — **January 13, 1947**

"Homestead's 160 in. 4-high Plate Mill" by WALTER H. GILLELAND, Assistant Division Superintendent, and W. D. HACKER, Division Superintendent, Slabbing and Plate Department, Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania.

Cold Finished Bar Steel

. . . . the ever-increasing requirements of industry have led to the development of new types of steel for cold finished bars, and new methods to process these materials . . . .

by Thomas D. Taylor

METALLURGICAL ENGINEER

BLISS AND LAUGHLIN, INC.

BUFFALO, NEW YORK

▲ THE cold finished bar industry began with a cold rolling process invented by Bernard Lauth at Pittsburgh in 1859. In that process, hot rolled wrought iron bars were cold reduced to finished size by repeated passes between driven rolls; the primary purpose being to make iron shafting at a lesser cost than by lathe turning. It is a matter of record that the inventor realized that this new process in addition to producing accurate size and bright, smooth surface, also imparted greater rigidity to the shaft.

Some years later as steel began to take the place of wrought iron in many of its uses, the cold rolling method was found to be equally suitable for steel shafting. This idea was used for about fifty years. The term cold rolled shafting accordingly came into general use and has persisted to describe, somewhat loosely, bar stock processed by cold drawing or other methods of cold finishing. The proper modern term is "cold finished bar steel."

Around 1890 the use of wire drawing methods was extended to sizes larger than $\frac{5}{8}$ in., a size range more properly classed as bars, and today cold drawing is the process by which most of the cold finished bar products are made.

It was soon found that the cold work in the drawing process produced practically the same physical properties in the metal, as were produced in cold rolling as caused by tension rather than compression.

Tensile strength	25 to 30 per cent increase
Yield point	60 to 80 per cent increase
Brinell hardness	15 per cent increase
Ductility	70 to 75 per cent retention

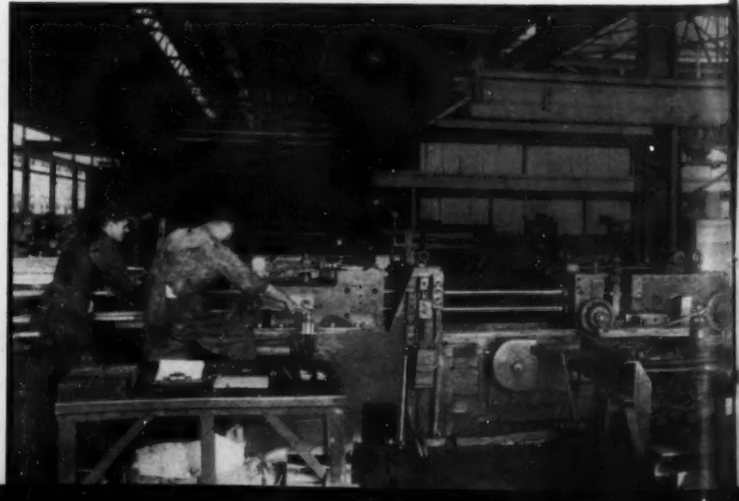
The two methods soon were regarded as equivalent and the more economical of the two, cold drawing, gradually replaced the older and more expensive method "Cold Rolling."

From 1890 to about 1915, cold finished bars were used principally as power transmission shafting of one kind or another in textile mills and factories generally, and as shafts in farm implements and other machinery. For that reason plants like Bliss & Laughlin, founded in 1891, were known as shafting works. Mass production

Presented before AISE' Buffalo District Section Meeting, March 12, 1946

Figure 1 — Prior to cold drawing, suitable hot rolled bars are exposed to acid pickling to remove mill scale.

Figure 2 — The bar is drawn in one pass to final dimension and shape.



of machine parts was still in its infancy and men such as Christopher Spencer, the inventor of the screw machine, were coming into the foreground.

With the growth of the automobile, the machine tool industry, household appliances, the radio, the airplane, in fact practically all machine manufacturing industries, the demand for cold finished bars for the manufacture of interchangeable machine parts broadened the use of the product and greatly extended the technology of the industry.

In the cold drawing of bars, suitable hot rolled bars or coils, rounds, squares, hexagons, flats, or special sections, are first exposed to acid pickling, sand or grit blast, or high pressure burning gas flame to remove the mill scale and then this is followed by water washing and liming of surface. The purpose of the lime is to provide an additional lubricant when the bar is drawn through a die. This mill scale should be of such a nature as to release readily and uniformily, or you may acid pit or burn the surface where the scale is released in an attempt to release the tight adhering scale at other places along the bar. If when this scale is removed a rolled in pattern remains, this is also bad because such patterns may squeeze up into pits in the final finish and take away from the desired smoothness and luster. In cold drawing there is no removal of bar surface. It is simply reduced in cross-section and elongated during drawing. The final finish of the bar is greatly dependent upon the results of pickling and liming, kind and design of drawing die, and drawing lubricant used. Of course, rounds can be passed through roll straighteners and polishers which increase the luster but other sections such as squares, hexagons, flats, and special or irregular shaped sections remain as die drawn.

By reason of the fact that there is no removal of bar surface during "cold drawing," all surface blemishes of hot rolling such as seams, laps, cracks, pits, slivers, surface decarburization, etc., remain as a contamination in the surface of the final product and are usually rejected. After the removal of scale and liming, the bar is drawn (in one pass) to its final dimension and shape, followed by straightening and cutting to some desired length. The bar ends are painted for grade identification, inspected, packaged and shipped to the customer via truck, open or closed cars, water or combinations of rail and water shipments.

The next most important method of cold finishing bars is turning and polishing. In this case hot rolled rounds from about 1 to 6 in. diameter are rough turned in centerless turning mills. Sizes larger than 6 in. round are turned on centers in special lathes. From $\frac{1}{8}$ to $\frac{1}{4}$ in. of the bars diameter is removed by turning. In this case, all hot rolling blemish equal to or shallower in depth than $\frac{1}{16}$ in. is removed and is no longer a part of the bar's surface. The rough turned bar is next passed between two hardened highly polished rolls. By means of a regulated pressure exerted by these rolls on the bar, the turning marks are ironed out to a smooth, high luster finish. This also straightens the bar as far as long bows are concerned but does not remove short kinks.

The bars are then straightened in a verifier straightener. In this case, the bar is revolved the same as it would be in its bearings and all kinks or conditions of

Figure 3 — Cold finished bars are sometimes rough turned in a centerless turning mill as shown, and then machine marks are removed by two polished rolls.

"out of straightness" are removed. The bar is then either lathe cut or saw cut to length, marked for grade identification, inspected, and shipped.

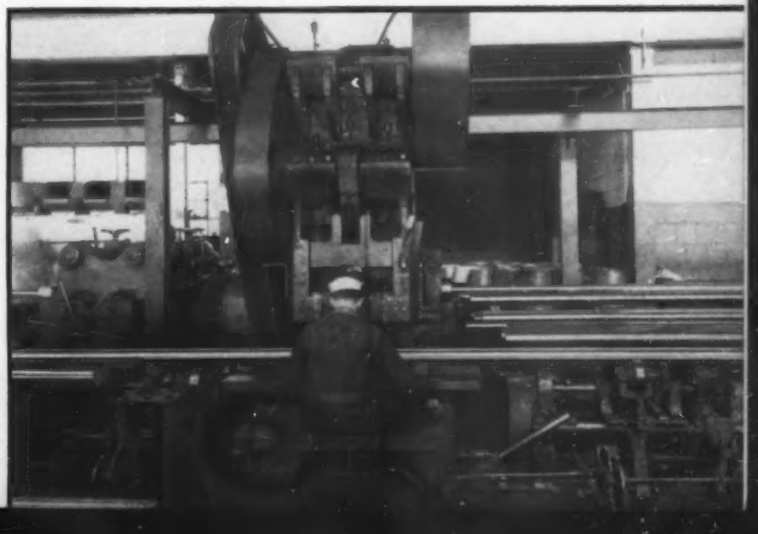
The physical properties of a turned and polished bar are very much the same as that of the hot rolled bar from which it was made, however, slightly changed due to a condition of compression set up during the roll straightening.

Either the cold drawn and straightened bar, or the turned bar can be surface ground in a centerless grinder thus producing in the former case a drawn, ground and polished bar and in the latter case a turned, ground and polished bar. In either case this type of bar is produced to a very close size tolerance, concentricity, condition of straightness and a high surface luster. The product is generally referred to as the aristocrat of the cold finished bar industry.

Ground bars of both types are used for precision applications or for shafts that are run at high rpm where vibration set up during rotation must be minimized.

Practically all grades of carbon and alloy steels, both open hearth or electric furnace, can be cold finished in either the as rolled or furnace treated structure condition. The only types that give considerable trouble would be steels that would work harden rapidly and set up a condition of spring that would interfere with straightening or bob back out of straightness after straightening. Such grades would be C-1095, E-52,100

Figure 4 — The bars are straightened in a verifier straightener.



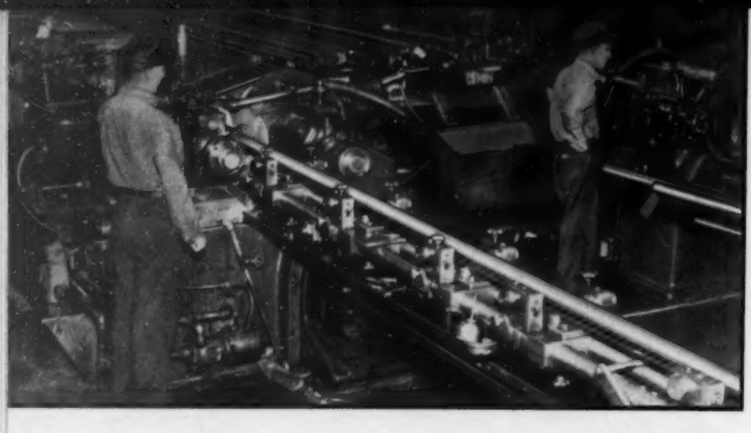


Figure 5 — The finest finish in a cold finished bar is obtained on a centerless grinder.

and 18-8 stainless or cutlery stainless. All of these grades are cold finished but only with close metallurgical supervision.

It is possible to procure the various grades, annealed, spherodized, sub-critical annealed or heat treated with cold finishing either before or after such treatment.

As early as 1926 it was found that by taking a steel bar of carbon content 0.30 per cent or higher; subjecting it to a heavy cold drawing and followed by a sub-critical temperature treatment, that two distinctly different types of finished bar could be produced from the same grade of steel.

If a temperature of around 800 F or less were used, it was found that the true elastic limit of the bar was doubled and the tensile strength, yield point, and bar hardness increased. That these developed physical properties for grades of steel 0.40 to 0.50 per cent carbon compared very favorably with about 80 per cent of the parts or shafts specified as simple heat treated, and fabricated from plain carbon grades or free machining grades of steel. This was very important because the method of production presented a bar less in cost and more uniform in physical property than it was possible to develop with a heat treated bar. It was also possible to apply this treatment to free machining grades of steel such as C-1144 and produce bars of a 0.40 to 0.48 carbon content in sizes up to 1 in. round with a tensile strength 125,000 to 145,000 psi and Brinell hardness of 250 to 302; or sizes 1 to 2 in. round of tensile strength 120,000 to 140,000 psi and Brinell of 235 to 285 or even bars of 2 to 3 in. round with tensile strength 105,000 to 120,000 psi and Brinell 212 to 255 that would machine in automatic screw machines, hand screw machines or lathes to within 15 per cent that of bessemer screw stock B-1112 when machined at 170 surface feet per minute.

This then gave rise to the term strain-tempered for physical properties and made possible in a great many cases the machining of parts or shafts (requiring strength not ordinarily expected in the as rolled condition) from supplied bars and eliminated all further heat treatment, cleaning up of parts after such treatment, corrective machining or restraightening, etc., that add expense and delay production because of such secondary operations.

By treating that bar above 1000 F and not over 1250 F, it is possible to present a bar free of strain. In this case the physical properties will be lower but the bar will not distort when machined. This is of importance for such parts as lead screws for lathes and shafts that must be held to close tolerances in machined dimensions. This type of bar is generally known as strain-tempered strain free.

For applications that afford heat lot quantities of steels in a single size or a family of sizes, it is possible to tailor the composition of the steel and treatment so as to meet some specific objective and create large savings for the maker of parts or final assemblies. This idea has been well accepted by all branches of the steel-using industry.

Up to about 1925 we had but one bessemer screw stock in the standard list then known as SAE-1112. Its machine performance based on modern ratings would be about 89 per cent and machined at 150 surface feet per minute. Its machine quality was not very reliable due mostly to a gummy condition of structure that at times caused poor tool life between grinds, burnt or broken tools, bug pick on tools, poor finish, inability to hold to close machined tolerances resulting in lost machine efficiency and decreased production. Long studies and researches were made resulting in a conclusion that beyond understandable accident some of the causes of this machining difficulty were:

1. Process of making ingot and pit practice.
2. Lack of proper control.
3. Free iron areas, the continuity of which were not properly or uniformily broken up.
4. Oxide areas.
5. Slag streaks and inclusions.
6. Too much silicon.
7. Lack of necessary amount of sulphur, phosphorous, nitrogen, etc.

About 1925 it was found that the Germans had advanced the sulphur content of Bessemer steel and improved the machinability. This fact finally ended in the presentation of a grade known as SAE X-1112 with a sulphur content of 0.10 to 0.18 per cent.

This change in sulphur plus a control of silicon which kept it as low as possible under 0.02 per cent with a carbon content around 0.10 per cent and improved control, ingot and pit practice helped the machining characteristics and reduced complaints considerably. In 1941, the standard AISI grade now known as B-1112 had a sulphur content of 0.16 to 0.23 per cent and machines very nicely at 170 surface feet per minute,

Figure 6 — Bars are cut to length either on shears as shown or with saws.

which represents about 10 per cent improvement in machining over the original SAE-1112. A high sulphur bessemer B-1113 with a sulphur content of 0.24 to 0.33 per cent is also available and will machine with good results at 225 surface feet per minute. This represents about 35 per cent improvement in machining over the original SAE-1112 or 25 per cent increase over the original SAE X-1112.

Further improvements in machining of bessemer steels is experienced by increasing the nitrogen content or by adding lead. These methods plus modern controls add another 15 to 25 per cent to the machining of bessemer screw stocks.

These free machining bessemers machine to a broken to a well broken — semi hard chip, and machine to a smooth bright character finish. They are ideal for the run of mine screw machine parts where shape and shape alone is the major requirement and undue severe physical properties are not required. The grades can be carburized and hardened, cyanided or liquid surface hardened for wear resistance but not for conditions of shock-load, repeat vibration or heavy stress.

Such parts or small diameter shafts made of bessemer screw stock should never be exposed to sub-zero weather conditions because they will become brittle under such exposure and break.

In the free machining open hearth grades and as late as 1926 there was only one standard grade available, SAE-1120. Its machine rating was 20 per cent less than SAE-1112 and machined at 136 surface feet per minute. It was too soft for exceptionally good machining and had a slight tendency to tear or machine to a rough finish.

It was used for parts or shafts requiring a low carbon open hearth free machining steel that for some reason either real or hypothetical could not be specified as a bessemer.

Today there are twelve standard low carbon free machining open hearth steels, two of which, C-1113 and C-1217, will machine 15 per cent faster than our present day bessemer screw stock, B-1112. There are four medium to high carbon free machining open hearth grades to take care of such parts that require machining, response to simple heat treatment or which will develop a file hard wear resistant surface when exposed to the modern induction hardening or flame hardening treatment. The two steels in this list that will undoubtedly attract a great attention in the next two years are C-1113 and C-1144.

With all these free machining open hearth grades available as standards today, it is safe to say that industry requirements in this field can be abridged or in another sense to say we are ready for the post-war period that holds such a bright possible future for American industry.

In the plain carbon non-free machining field, we have two standard cold finished grades, C-1008, and C-1010 for rather heavy or drastic cold deformation. We have five grades suitable for carburizing and hardening, grades that will develop a file hard surface and retain a soft ductile core. All of these low carbon grades have very poor machining characteristics and get worse as the carbon content decreases. They machine to a soft-continuous type chip and will tear rather than machine to a bright finish.

As the carbon content approaches that of C-1030 or 0.28 to 0.34 per cent, the machining in the rolled state improves. It is best with C-1030 and then starts to drop away as the carbon and bar hardness increases.

As was true in the case of bessemer steel, the machining can be improved by increasing the sulphur content or adding lead. With carbons over 0.34 per cent up to and including 0.55 per cent, the machining can be improved by furnace treatments for developing a coarse, blocky type, lamellar, pearlitic structure. For carbons over 0.55 per cent, the structure should either be mixed or spherodized to a coarse type structure.

In the alloy types machining can be improved by adding even slightly to the sulphur content. For example by taking a heat of steel showing 0.029 per cent ladle sulphur and increasing this to 0.055 per cent improves machining 15 to 20 per cent.

Machining of the alloy grades can also be improved by normalizing, annealing or spherodizing as the case may demand. This article has extensively discussed the subject of machining because this phase has played a major part in the twenty years of my steel experience. It seems also that in the face of that which lies ahead of us, and in order to keep industries competitive, we as steel makers and producers must see to it that the fabricating industry gets all possible out of the steel they buy, in the way of better machining, improved forging results, bending, cold deforming, welding, brazing, or whatever the operation may be, especially in the face of increased labor and material costs.

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Continuous Strip Annealing

. . . . by using some of the heat in the strip to preheat the incoming strip, continuous electric annealing may be done at a cost no greater than that of the conventional batch annealing . . . .

by E. J. Seabold

DEVELOPMENT ENGINEER

THE DREVER COMPANY

PHILADELPHIA, PENNSYLVANIA

▲SINCE the advent of continuous cold mills for reducing low carbon steel strip to final gauge, remarkable progress has been made by the steel industry in developing new and higher speed continuous operations. This progress, intended to reduce costs and to meet the increased demands for prompt deliveries, is impeded somewhat by the long heat treatment required after tandem mill rolling, the product being first subjected to a cleaning operation to remove the rolling lubricant, and then to a long, low-temperature batch anneal. The annealing process is carried out in cover or hood type furnaces and requires some 100 hours for completion. The present trend, therefore, is toward annealing strip in strand form with a cycle of heat treatment which is only a matter of minutes in length. This transition appears necessary in order to eliminate the long heating and cooling periods which are unavoidable when annealing in coil form.

There are many designs of continuous strip furnaces, both electric and radiant-tube heated, and mostly of the single strand, straight-through type. Several strip furnace lines have been installed in steel mills, and electric heating has been incorporated in the design. This type of heating is preferable because of the simplicity of design and the ease with which desired temperature conditions within the furnace can be reproduced. The cost of electric heating is naturally greater than that of heating produced by the combustion of fuel and this has limited to some extent the utilization of continuous annealing. Accordingly, it is the purpose of this paper to present a furnace design for strand annealing with an improved cycle of heat treatment and with the thermal efficiency increased by heat exchange between strip leaving the furnace and the entering strip.

The type of furnace to be discussed is known as the "Electric heat-exchange furnace," which has two important advantages. One factor is the slow initial cooling rate from the maximum temperature to about 900 F, and secondly, the design permits the recovery of about 45 per cent of the heat imparted to the strip. It will be apparent that, with this method of annealing low carbon steel strip, electric power may be utilized with an overall cost no greater than that of the conventional batch annealing.

Continuous strand annealing furnaces for both ferrous and non-ferrous materials are not new. Many units are in operation and performing satisfactorily. The problem has been, however, to design a unit to produce up to 15 tons an hour, consistent with the requirements of good physical properties, micro-structure and operation, and equally as important, costs that are within the limits of costs of the present method. One of the principal advantages of strand annealing is the additional savings resulting from the fact that the cleaning of the strip is combined with the annealing. It will be appreciated that this avoids the extra handling necessary when the cleaning operation is conducted separately, as well as the cost of a separate cleaning line.

ANNEALING PRACTICE

For strip steel such as that produced on cold reducing mills, the relief of strain consists of low temperature, long time heat treatment below the lower critical point, in which no structural changes are involved. Higher temperatures are prohibitive due to overheating the outside wraps of the coiled material and the resulting sticking or welding which would occur.

In contrast to this method, the material in strand form is heated to temperatures ranging from 1330 to 1725 F. The mass effect so troublesome in batch annealing is eliminated and adjustment to the particular

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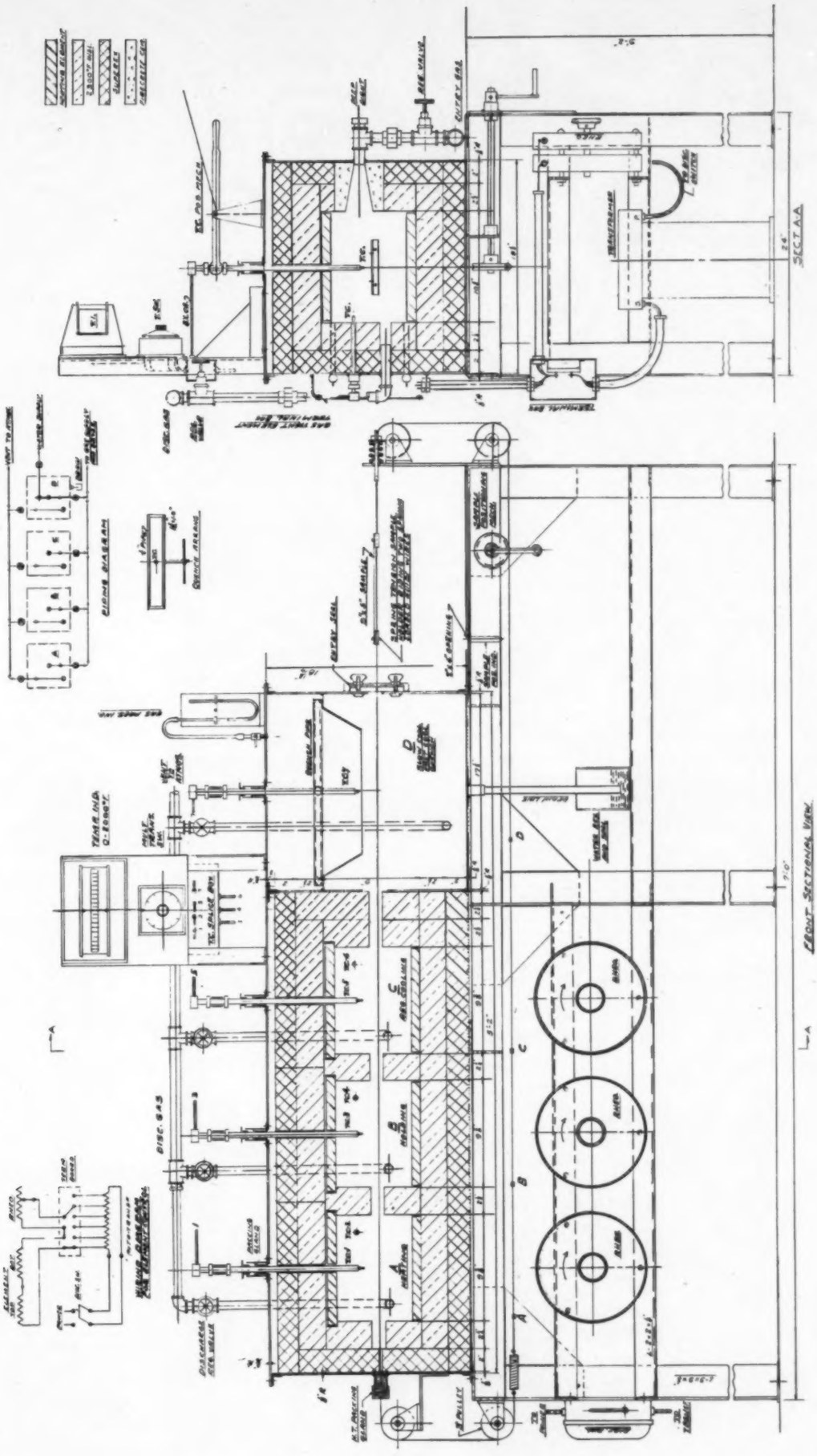


Figure 1 — This apparatus was developed so the metallurgical laboratory could check any part of the cycle using 5 in. × 9 in. samples.

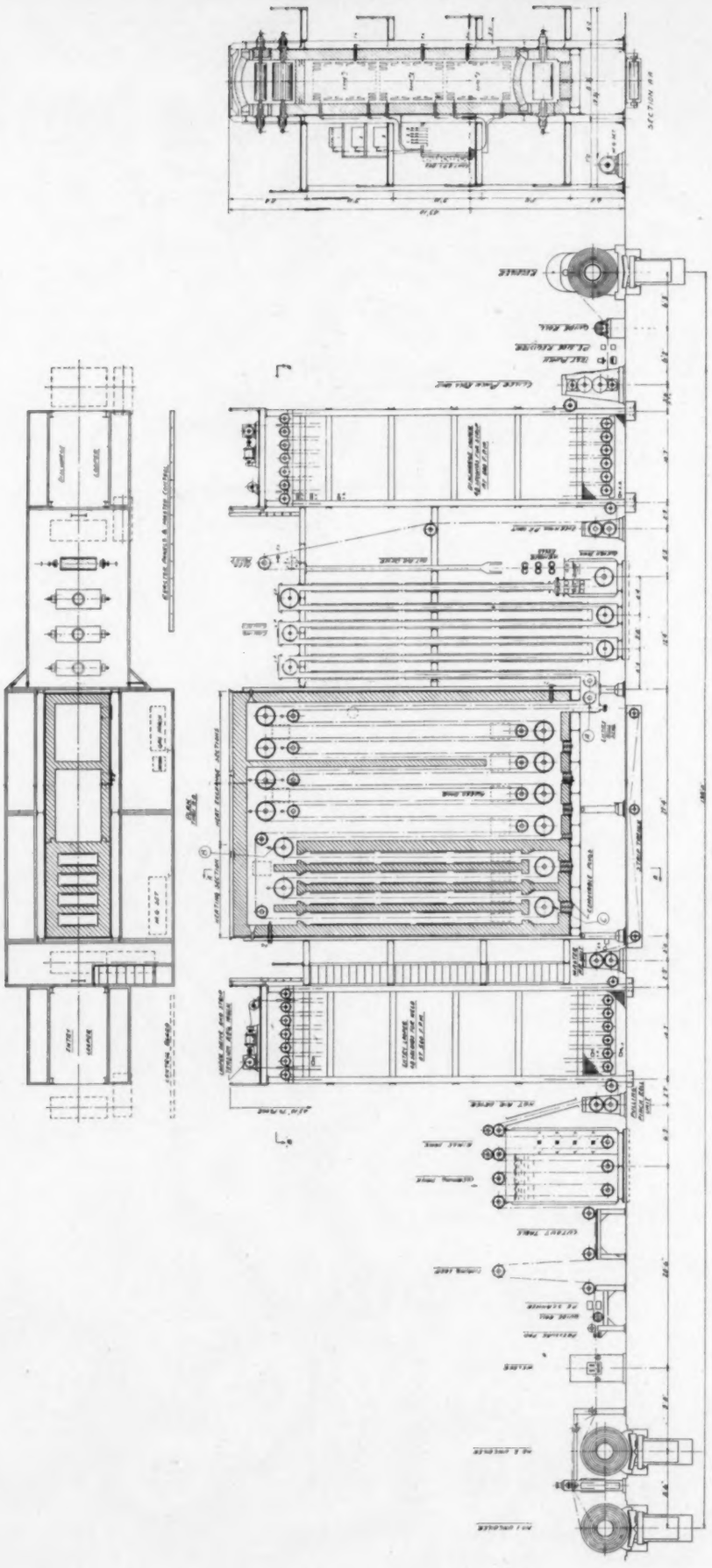


Figure 2 — Arrangement of continuous strip cleaning and annealing line.

heat treating cycle quite simplified. Heating and cooling a single strand permits more accurate control of the time-temperature cycle and greater flexibility of heat treatment. The desired relief of strain and refinement of grain can readily be accomplished, with the accurate top temperature, soaking and regulated cooling applications, which are possible when annealing in continuous strip furnaces.

Far greater uniformity of anneal throughout the coils is possible by this method, since every part of the coil is exposed to substantially the same annealing conditions. This is not true when the coils are annealed as a unit in the batch method; the outside of the coils are up to temperature a great deal longer than the interior.

A very troublesome characteristic of batch annealed material is the frequent occurrence of dark areas on the edge of the strip. This discoloration on the surface is said to be an "iron carbide compound". This condition of strip does not occur in the continuous method here under discussion. The reason probably lies in the limited time of exposure to high temperatures and the furnace gas atmosphere. A uniformly bright strip is easy to obtain by this method, because the surface of the strip is completely exposed to the reducing action of the furnace gases throughout the heating and cooling cycle.

Annealing practice may be firmly established for the various tempers when it is possible to reproduce exact physical properties and micro-structure for a given set of chemical constituents. A sound basis of heat treatment may be instituted, by placing at the disposal of the annealing department, for variation as desired, such important factors as the economical use of wide temperature ranges, control of the rate of heating, the time of soaking, the rate of cooling through certain temperature ranges and the adjustment of strip speed to vary the annealing treatment. These so-called tools of the trade can be the simple means of compensating for variations in gauge and width, and also for the variations that occur in the constitution of the steel, which may call for modified heat treatment.

In cooperation with this method of heat treating, the metallurgical laboratory may be equipped with a small testing apparatus for 5 × 9 in. samples wherein any cycle can be taken apart and explored in seconds for application on the production units. Hardness, ductility, grain size, tensile strength, yield point and aging, for the various compositions, can be predicted by the laboratory for cycles that are adaptable to the furnace installation. Figure 1 is an outline of such an apparatus for testing.

Further references to heating and cooling rates are intended to be in degrees F and are made with the use of the term "degrees per second average". This term represents a method of determining the rate of heat absorption or rate of heat dissipation through certain temperature ranges, for either cleaned or uncleaned materials. It can be used to measure the value of heating and cooling cycles for the various gauges in relation to the constitution of the steel. In testing, with 0.010 in. material and with element temperatures at 1825 F, the fastest rate of heating obtained, for complete penetration without soaking, was 14 seconds to 1330 F or 90 degrees per second average and 27 seconds to 1725 F or 61 degrees per second average. For the cooling rates, satisfactory material was produced with a rate of temperature dissipation from 1725 to 900 F in 32 seconds, represented by 26 degrees per second average, and from 1330 down to 900 F in 21 seconds or 20 degrees per second average.

FURNACE ARRANGEMENT

From information and data compiled and through experimenting with numerous cycles and combinations of cycles, samples were produced and reproduced to indicate the desired short cycle. The furnace arrangement incorporating all of the known advantages was decided upon and is indicated by Figure 2. This design provides for low temperature annealing of 26 to 38 in. wide by 0.0075 to 0.020 in. thickness cold rolled strip steel at 15 tons per hour, with 1330 F top temperature of the strip and then through the range of temperatures up to high temperature annealing at 1725 F at 7½ tons per hour.

The time-temperature curves (Figure 3) were plotted from the furnace arrangement, and testing was continued on the exact number of seconds representing each phase of the various cycles. The curves shown are for the 1330, 1550 and 1725 F cycles. Each cycle of heat treatment is divided into six component parts as indicated in the table of Figure 3. As applied to the continuous furnace arrangement, each cycle represents a preheat section, three heating sections, holding section, slow cooling and heat exchange section, final cooling and quench. The table also indicates the time in seconds and degrees per second average, for the particular temperature range represented by each part of the cycle. The tonnage and total power required to heat the strip and supply furnace wall losses, per net ton of material processed, for each of the three cycles of heat treatment completes the table.

Figure 4 shows the comparison of physical properties obtained with these top temperatures of 1330, 1550 and 1725F, with 0.010 in. material of the chemical composition indicated. All samples were taken from the center of the strip. As would be expected, the tensile, yield and hardness decrease with longer time and higher temperatures, while ductility and elongation are increased.

The complete furnace line includes the conventional strip handling equipment, such as the two uncoilers and multiple seam welder, photo electric scanning equipment, cleaning tank including rinsing and drying, pulling pinch roll unit, entry looping tower and master pinch roll unit. Next comes the furnace arrangement, consisting of the high temperature heating sections and heat exchange section, and the arrangement of cooling chutes, quenching, rinsing and drying. Next in the path of the strip travel is a flexible roll arrangement, overhaul pinch roll unit, discharge looping tower, coiler pinch roll unit, a method of side guiding the strip, and the recoiler. Space is provided for a movable test punch. Certain of these units will be described in more detail later in the paper.

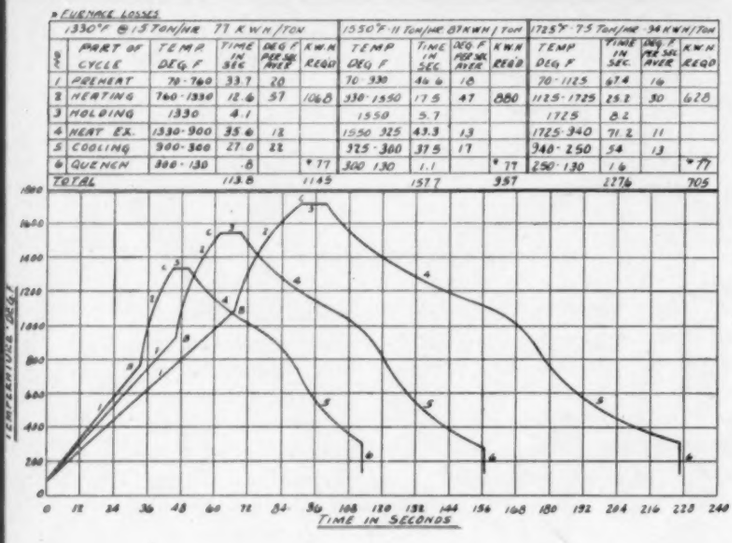


Figure 3 — Time-temperature curves for three temperature cycles of furnace operation.

PREHEAT SECTION

The incoming strip, after passing through the strip trench, which is intended to keep the underside of the furnace clear, enters the preheat section of the furnace arrangement through the entry roll seals at point A, of Figure 2 and parallels the outgoing strip through a series of nine vertical strands for a travel of 280 feet to point B. Considering the processing of cold rolled strip 30 in. wide by 0.010 in. thick, traveling at a uniform speed of 500 feet per minute, and assuming that the maximum temperature of the strip is 1330 F, the material is heated from room temperature to approximately 760 F by radiation from the previously heated portions of the strip leaving the furnace. This stage of the complete annealing cycle is indicated by the first portion of the curve on Figure 3, the average rate of heating being about 20 degrees per second.

HEATING SECTIONS

The strip then enters the high temperature heating furnace and in its travel through three heating sections, its temperature rises more rapidly, at an average rate of about 57 degrees per second, as indicated by the second portion of the curve of Figure 3, to a final temperature of 1330 F. In passing through these heating sections the strip is exposed to direct radiations from wall type resistor heating elements. To avoid overheated edges and local hot spots, heat is applied in gradual manner with a somewhat higher wattage impingement in the center of the strip, by a bunching of resistor capacity in the center of the element and allowing conduction to keep the gradients low.

Rather than use the more complicated operating procedure required with on-and-off control, where it is necessary to hold the furnace in thermal balance with the movement of the strip, it has proven to be more advantageous to operate each element section at some constant heat output that is in equilibrium with the heat absorbed by the strip while moving at a speed which is proper to produce the desired top temperature. For this purpose, saturable core reactors are used to automatically regulate the flow of power to the heating elements, by varying the voltage, in accordance with predetermined temperature requirements of each furnace section.

The advantage of this method of control lies in the fact, that individual portions of the strip are subjected to the same heating conditions, rather than the irregular conditions encountered for instance, with on-and-off control, when the strip may at one moment be exposed to violent radiations from a brilliant element and at another moment to be feeble emanations from a dull element. This method is profoundly important in the production of strip that is of uniform anneal throughout its length.

HOLDING SECTION

In traversing the final pass of the heating furnace the strip is held at its maximum temperature, as indicated by the third portion of the curve of Figure 3. This furnace section constitutes a holding or soaking zone, which serves to iron out inequalities in temperature across the strip by conduction and allows time for penetration of the mass effect, which incidentally is an important factor even with material 0.010 of an inch in thickness. The resistor heating elements in this section of the furnace will also be voltage regulated, with the setting of the control instrument approximating that of the desired top temperature of the strip.

SLOW COOLING AND HEAT-EXCHANGE SECTION

The heated strip then enters the heat-exchange section of the furnace arrangement and parallels the incoming cooler strip, through a series of nine vertical strands, for a travel of 296 feet back to point A of Figure 2. Initial cooling from the top temperature of 1330 F to approximately 900 F, while traveling at a speed of 500 feet per minute, occurs at an average rate of 12 degrees per second as indicated by the fourth portion of the curve, of Figure 3.

The primary function of this arrangement of parallel strands is to provide an inexpensive method of slow initial cooling. It will be apparent that this may be accomplished without the use of additional cooling means, which would otherwise be necessary for controlled cooling through the desired temperature range. Another very important purpose is that of heat recovery; in this respect it makes possible the use of high temperatures for annealing with very little increase in the power cost per ton, and thereby permits the use of electric power with an economy approaching that of the present day gas fired batch annealing furnaces. The design as shown has been rated at 43, 49 and 53 per cent heat recovery for the 1330, 1550 and 1725 F cycles

respectively by an authority on the subject of heat transfer.

Several installations are producing material with cooling rates in the vicinity of 85 degrees per second average from 1330 F to approximately 800 F. With a slower rate of cooling through this range, that is, 25 degrees per second or slower for 0.010 in. material, improved physicals and grain refinement can be expected and less aging or work hardening will occur in subsequent operations. Whereas the Rockwell hardness improvement at the furnace may indicate only a point or two, the finished material after temper rolling and coating will be 4 to 5 points lower, and in consequence embrace a wider range of use than material annealed in the lower temperature range.

COOLING CHUTE SECTIONS

The strip then enters the final cooling chute arrangement and in its passage through six vertical sections is reduced in temperature from 900 to about 300 F. In the 225 feet of travel through these cooling chutes, the temperature of the strip falls at an average rate of 22 degrees per second as indicated by the fifth section of the curve of Figure 3. These cooling chute sections are of light gauge sheet steel construction, with properly reinforced water jackets located on each side of the strip. Cooling water in the amount of 71 gpm or 284 gal per ton will be required for cooling the strip through this temperature range. A set of quick opening discharge rolls is located at the end of the last cooling chute section, just above the water bath, to effect a gas seal between the cooling chutes and quench tank.

QUENCH TANK, RINSING AND DRYING

The principal reason for water quenching the strip is to provide for immediate temper rolling; otherwise 36 to 48 hours would be required for uniform cooling. After passing through the discharge rolls the strip enters the water bath and is cooled almost instantly from 300 to about 130 F, as indicated by the sixth portion of the curve of Figure 3. Any water vapor present in the section between the rolls and the water bath is removed by passing the furnace gas atmosphere coming direct from the drying towers through this section. This gas picks up the vapors and continues on through a pipe header to enter the high temperature heating sections at a dew point of a few degrees less than the temperature of the cooling water supply, or low enough to prevent condensation on water cooled surfaces.

Cold water additions in the amount of 16 gal per minute or 65 gal per ton, are made through drilled header pipes located on each side of the strip, several inches under the water level, at the point of entry of the strip. At the exit side of the bath, hot water sprays thoroughly cleanse the strip. Above the sprays are three sets of wiper rolls, two sets of which are in constant use while the remaining set acts as a spare for continuous operation. The strip then passes through a section of drying chute where hot air is used for the final drying.

FLEX POINT

At the top of the drying chute, the strip is directed over a movable roll arrangement that acts as a flex point to prevent a tension build-up in the furnace strands. This roll is counterweighed for what is considered to be the maximum desired strip tension and acts as a safety valve for possible faulty operation of the pinch roll units. If the strip tension exceeds the amount of the counterweight, the roll arrangement moves downward and trips the emergency stop switch to stop the entire line.

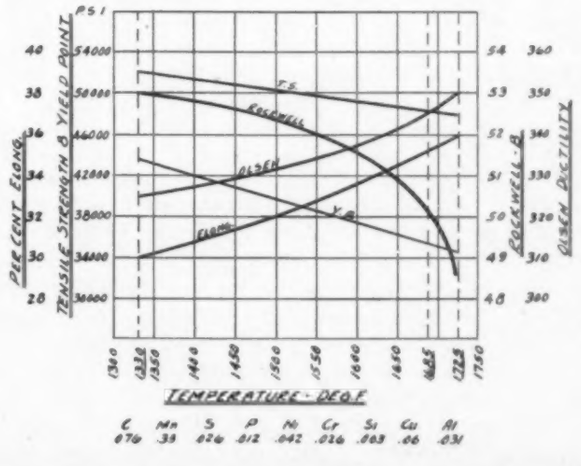
STRIP HANDLING EQUIPMENT AND CONTROLS

The necessary strip handling equipment for continuous processing of the material, together with the line controls, will not be discussed in this paper as these items will vary with the particular requirements of each individual steel mill. The furnace, entry and discharge loopers, photo-electric scanner, and means of threading the furnace at high temperature are, however, worthy of a general description of design and operational intentions.

FURNACE DESIGN

The furnace is of the vertical tower type suitably insulated for 1900 F. Rolls and shafts are of high strength alloy and are equipped with combination roller bearing, low temperature lubricated packing gland and water connection. Explosion ports, quick opening roll type entry seals, access doors with movable insulated plug to follow the expansion and contraction of the furnace brickwork, and portable equipment for removal of furnace rolls and bottom insulated plugs, and for transporting the leader strip, together with special devices to aid in rethreading, are a few of the features of the furnace design. Pipe connections for fast purging of the inert or reducing gas atmosphere are located in each furnace section. Platforms with stairway access extend from the furnace superstructure for access to

Figure 4 — Variation of physical properties with top temperature.



zone connections, thermocouples, bearings and doors, and for removal of rolls and mounting of electrical equipment.

The heating arrangement consists of eleven 160 kw zones, three 160 kw zones in each of the three heating sections and two 160 kw zones in the holding section. The reason for this much power in the holding section is that it may be used to full capacity in the direction of increased production if the material is intended for a particular use, such as — light forming, stamping or can end stock. Each zone consists of two 80 kw units, one on each sidewall, arranged in a festoon of six rows each with terminals extending through the furnace wall for the single phase connections that are in turn balanced on a three phase bus. Contactors and overloads provide protection for each of the eleven 160 kw saturable core reactor circuits. Properly spaced alundum plugs between the rows of heating elements prevent injurious contact by the strip. Thermocouples are located so as to indicate the top temperature and discharge temperature of the strip for repeating the particular cycles decided upon. Automatic temperature control equipment for each heating zone and auxiliary instruments for indicating furnace gas pressure, line speed and strip temperatures are a part of the control panels associated with the furnace.

For bright annealing in this type of furnace, any clean fuel gas will protect the steel if it is prepared by burning with an insufficient supply of air, cooled to eliminate the major portion of the water vapor, and then passed through a dehydrator to further lower its moisture content to the desired dew point. The gas enters the furnace in the amount of 2500 cu ft an hour, flowing to each of the three heating sections. The flow is toward the cooling chutes to a vent pipe located just above the discharge rolls. A positive pressure of about 0.3 of an inch of water is maintained during operation.

LOOPER DESIGN

The entry and discharge loopers each comprise a four column structure with stationary rolls at the top and movable carriage. Each looper consists of 12 strands, providing 398 feet of strip, which allows 48 seconds to make the weld or remove the finished coil. Four flexible wire rope cables support the carriage and turnbuckles permit leveling as required. Suitable spring loaded rollers ride the columns and prevent sway. Counterweight over and above the weight of the carriage if required, is inserted in the channel iron base.

The drive unit, located on top, is adjustable tension regulated for cable overhaul and to counterbalance the carriage in accordance with the requirements of varying gauge and width of strip. When the line is not running, this unit is used for positioning the carriage by forward and reverse inching. An overspeed device located on the drive unit, acts to stop the line and set the brake of the drive unit, if the down travel of the carriage is greater in feet per minute than 1/12 of the maximum feet per minute output of the pulling pinch roll unit. It would indicate that the strip has parted and a crash of the carriage is to be avoided.

PHOTO-ELECTRIC SCANNER

Occasionally, coils of strip steel coming from the tandem mill will contain one or more bad edges. If these are not detected during processing of the coil, they may cause the strip to part in the furnace. To require an operator to watch for these defects, which may not occur more than once or twice in a day's operation, is not possible, due to the monotony of the assignment. Therefore, detection must be automatic and positive for good furnace operation.

For this purpose, a photo-electric means of scanning the edges of the strip is located just after the welding operation. The unit consists of an adjustable width, flanged type, endwise floating roll arrangement, a standard photo-electric scanning unit, a mechanical timer, vertical loop and cutout table. This apparatus automatically inspects the coils from a point ½ in. inside the edge of the strip, inwardly for about 4 in. on both sides. Damaged edges extending beyond ½ in. are detected by the scanner, and the mechanical timer then acts to stop the strip with bad edge over the cutout table. Indicating lamps show on which side the cutout has to be made, and for the convenience of the operator, stop, restart, inching and slow-down buttons are located at the cutout table.

THREADING THE FURNACE

Initial threading of the furnace usually is done while the furnace is cold. Threading may also be done when the furnace is hot or when the strip parts during operation. To accomplish this, pipe sleeves extend through the furnace shell and brickwork, 6 in. above the top of each of the top furnace rolls and on the center line of the roll. Access doors are located top and bottom, and removable bottom plugs provide an opening for removal of strip and for access to the strip for splicing. These plugs are removed by an adjustable hand operated geared carriage and deposited on a suitable rack. In the center of the plug is a pipe sleeve with peep sight to assist in locating the break. Peep sights are also located at each end of the furnace on top for a full view of each of the outgoing strands. With these facilities and the use of threading pipes, rods, nichrome wire, leader strip and a portable spot-welder, any section of the furnace can be rethreaded at high temperature.

METALLURGY OF THE PROCESS

It is well known that the variations in the composition of the steel materially affect its response to quick heat treatment, under conditions of the same heating and cooling cycles. The flexibility of the furnace arrangement results from the many combinations of time and temperature that are available through changes in the speed of travel of the strip, and the ease with which the heat energy delivered to the strip may be controlled, as well as the soaking time and slow initial cooling rate. These are the compensating means by which the required physical properties and micro-

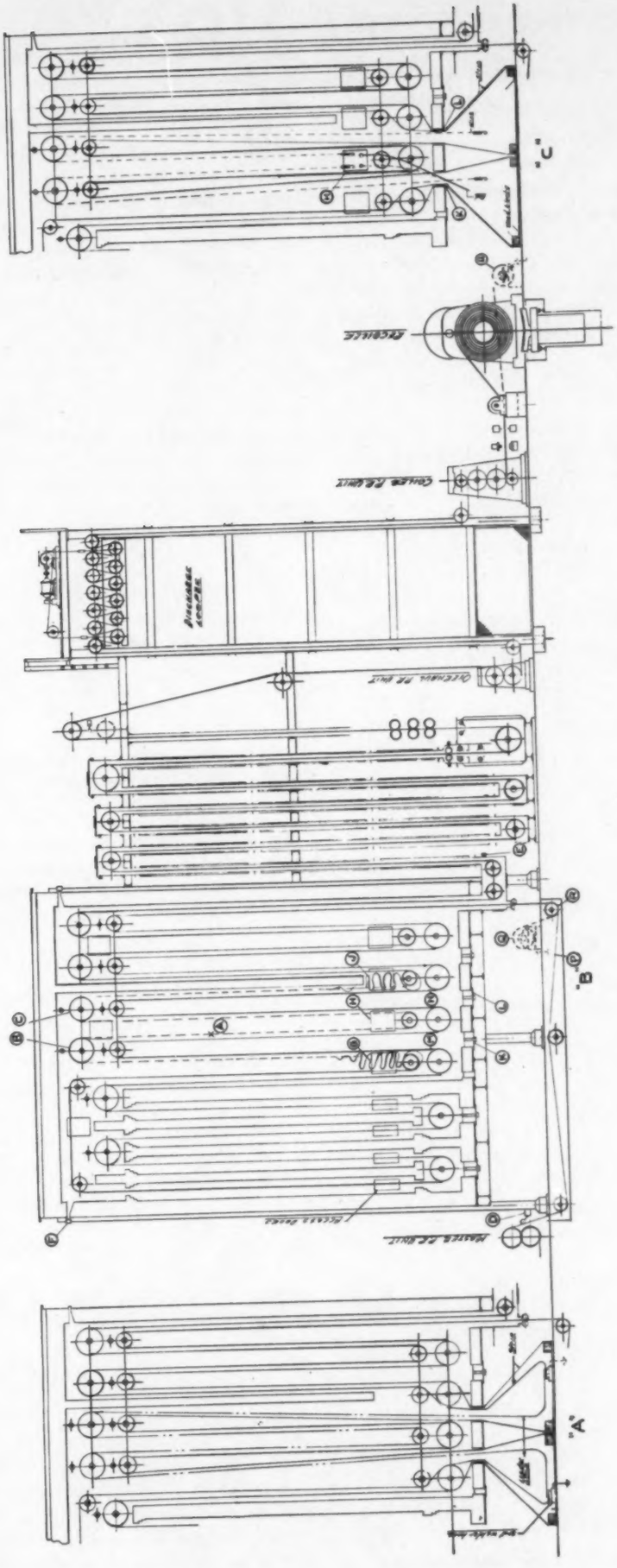


Figure 5 — Section through furnace showing location of simulated break.

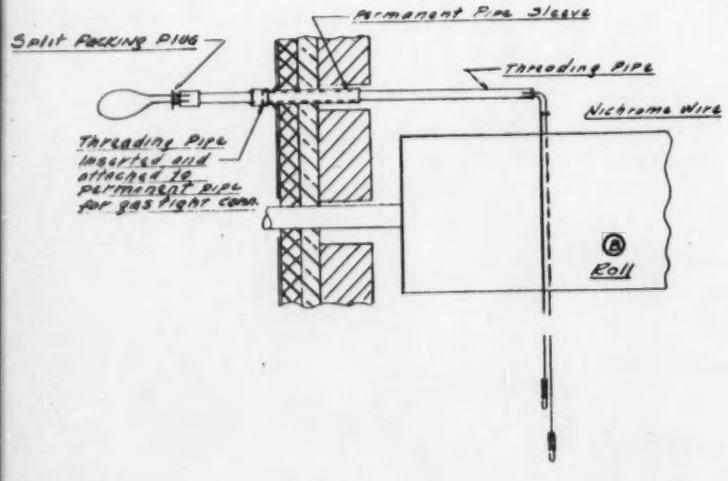
structure may be obtained with the varying composition.

Although it is possible to get consistently good results in both hardness and ductility with top temperatures below the critical or 1685 F, the desirable characteristics produced with the use of temperatures above the critical or 1725 F has indicated that the effects of variations in composition are somewhat neutralized by this procedure. Physical properties are very uniform over a wide range of C, Al, Ni, Cr and Cu content, and it may be termed an overall cycle. The advantages are attractive from the standpoint of economical use and and the broad applications possible with one classification of material, over a wide range of drawing and forming operations, to justify its use for that portion of the production where quality is the all important factor.

A peculiar characteristic of this material that is considered a desirable quality is the tendency of an un-skinpassed sample to bend over a broad area when subjected to bending or flexing. Batch annealed, low temperature continuous annealed, or fast normalized strip steel does not possess this peculiarity but yields locally and sharply at one point. It is indicated by a dovetail grain pattern and the physical properties in both directions are exceptionally uniform. For 0.010 in. material with carbon at 0.08 per cent, the hardness is 48 Rockwell-B, Olsen ductility 355, yield point 32,000 psi, tensile strength 45,000 psi, elongation in 2 in.—38 per cent and grain size 7 to 8. One theory is that this peculiar grain arrangement is the result of stretch and flexing over the furnace rolls during the heating and cooling cycle. Furnace stretch is measured at $\frac{1}{32}$ of an inch in 25 inches and this may be due to pulling out buckles, etc., and not to actual stretch. Flexing is the only remaining logical answer as this same material can not be reproduced on the test furnace under conditions of exactly the same cycle.

Superficial Rockwell hardness tests, as practiced in the steel mills today, are definitely not an indication of the drawing or forming qualities of continuous annealed strip, and can not be correlated with the hardness values obtained in the batch method. Continuous annealed strip will show a higher hardness, slightly higher tensile and yield point but with a higher elongation and ductility figure, and will withstand deep drawing, severe forming and threading operations as well as batch annealed material.

Figure 6 — Enlarged section of roll "B."



PROCESSING COSTS

Strand annealing may be accomplished by the use of temperatures from 1330 to 1725 F with very little increase in the power cost per ton, for it can be readily understood that this cost is represented by the discharge temperature of the strip plus furnace losses. It necessarily follows that the higher the temperatures and the longer the time, the more effective will be the heat-exchange. The thermal efficiency, with which power may be utilized per net ton for this particular arrangement of strands, would be:

Furnace cycle	Tons per hour	Fpm	Kwh per ton	Ratio*
1330 F	15	500	77	145 per cent
1550 F	11	367	87	163 per cent
1725 F	7½	250	94	166 per cent

*These figures represent the ratio of total heat content of strip at furnace temperature to heat supplied to the furnace.

Subsequent figures on cost are based on low temperature annealing at 15 tons per hour with power at $0.007 per kwh, water at $0.06 per 1000 gal, prepared gas at $0.08 per 1000 cu ft and labor at an average rate of $1.25 per hr. Amortization is not included in these costs as this item is computed differently in each plant.

1. Top temperature of the strip 1330 F requiring 200 Btu per lb.
2. Discharge temperature of the strip 900 F or loss of 110 Btu per lb.
3. Heat exchange furnace losses represented by 1455 sq ft of exposed wall area at an average loss of 124 Btu per sq ft per hr or 6 Btu per lb.
4. Efficiency of the heat exchange section 43 per cent. This allows 84 Btu per lb transfer to the incoming strip, which raises its temperature from 70 to 760 F.
5. Power required for heating the strip from 760 to 1330 F, represented by 116 Btu per lb, is 1019 kwh or 68 kwh per ton.
6. High temperature furnace loss for 1080 sq ft of wall area at an average loss of 175 Btu per sq ft per hr is 3.7 kwh per ton.
7. Water cooled shaft losses are 10 rolls at 10,000 Btu per hr each or 2 kwh per ton.
8. Atmosphere gas heating to 1800 F is 1.7 kwh per ton.
9. Power required for operation of the line is approximately 150 hp or 7.4 kwh per ton.
10. Reactor losses are 5 per cent of the total power required for heating the strip and for supplying high temperature furnace losses, or 3.8 kwh per ton.

11. Cooling water to dissipate 102 Btu per lb, represented by the temperature decrease from 900 to 130 F with cooling water at 60 F and discharging at 130 F is 349 gal per ton or 87 gal per min.
12. Furnace gas atmosphere requires 2500 cu ft per hr.
13. Labor required for operation of the line, 3 operators.

Summary of the cost per ton:

(5.) Power for heating the strip 68.0 kwh at $0.007 per kwh	$0.476
(6.) Wall losses 3.7 kwh at $0.007 per kwh	0.026
(7.) Shaft losses 2.0 kwh at $0.007 per kwh	0.014
(8.) Atmosphere gas heating 1.7 kwh at $0.007 per kwh	0.012
(9.) Operation of the line 7.4 kwh at $0.007 per kwh	0.052
(10.) Reactor losses 3.8 kwh at $0.007 per kwh	0.027
(11.) Cooling water 349 gal per ton at $0.06 per 1000 gal	0.021
(12.) Atmosphere gas 2500 cu ft per hr at $0.08 per 1000 cu ft	0.013
(13.) Labor	0.250
Total cost of annealing per ton	$0.891

The cost of washing powder, steam and rinse water can be added to this cost and the present cost of cleaning the strip then deducted. It will be obvious, then, that a very substantial savings can be effected with the use of this method of annealing. Further economy results from the following additional advantages, some of which are in operations that follow the annealing:

1. Improved quality of low carbon steel.
   a. Control of grain size.
   b. Uniform physical properties.
   c. Coarse grain structure common to low carbon steel eliminated.
   d. Superior drawing and forming properties.
   e. Clean bright reduced surface.
2. The high degree of uniformity possible only in strip annealing.
3. Eliminate the separate cleaning operation.
4. Put annealing in line with straight line processing; save time, labor, handling, storage; avoid delays, and hold investment in stock to a minimum.
5. Eliminate stickers, damaged coils, oxidized and grey edges.
6. Higher temper mill production. No mechanically locked edges or stickers and with uniform shape produced after annealing regardless of tandem mill shape. Satisfactory shape and temper on one pass for a large per cent of the tonnage. This will eliminate the shot blast rolls where 0.018 in. is lost on each grinding as compared 0.0025 in. for slick rolls.
7. Clean bright reduced surface for light weight electro-tin coating.
8. White pickling operation prior to hot dip tinning may be reduced to a few seconds in line pickling due to the clean surface.
9. No bridge cranes or up-enders required and four less handling operations for the same routine from cold reducing to temper rolling.
10. Lower maintenance and replacement costs and substantial reduction in the capital investment required for like tonnage in batch annealing.

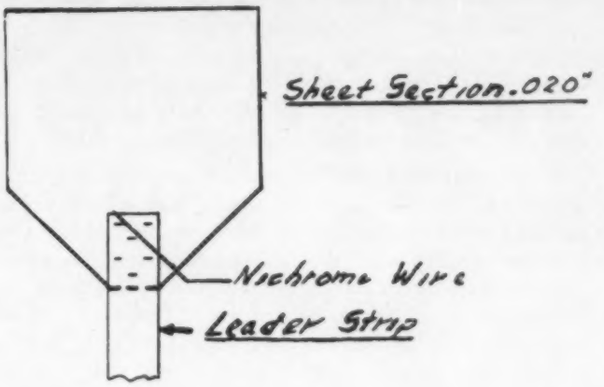


Figure 7 — The leader strip is attached to the sheet section.

CONCLUSION

In summarizing the advantages of continuous strip furnaces employing the heat-exchange principle, it will be evident that this method of heat treating low carbon steel strip is characterized by numerous gains. Among these are the speed of processing, which enables finished material to be shipped the same day it is cold rolled, and the production of material having good physical properties and micro-structure in substantial amounts, that is, up to 15 tons per hour, at an overall cost no greater than the present method of annealing in batch furnaces. One factor in the economy is the fact that this method permits the recovery of about 45 per cent of the heat imparted to the strip. Further economy is effected by the fact that the cleaning of the strip is combined with the annealing. This opportunity to combine processing steps is in line with a basic trend in the steel industry today, as it reduces material handling with its attendant waste due to damage.

DISCUSSION

PRESENTED BY

W. N. HORKO, Henry Disston and Sons, Inc., Tacony, Philadelphia, Pennsylvania

E. J. SEABOLD, Development Engineer, The Drever Company, Philadelphia, Pennsylvania

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

A. M. QUINN, Hagan Corporation, Philadelphia, Pennsylvania

NORMAN C. BYE, Henry Disston and Sons, Inc., Tacony, Philadelphia, Pennsylvania

W. N. Horko: Mr. Seabold mentioned the advantage of the constant power input over the on-and-off type of control through various sections of the heating and soaking part of the furnace.

How would an operator know what the proper input

should be and how could he be sure the band is being heated in all the passes of the furnace before it reaches the soaking part of the furnace?

Also, what type of fire brick is used in the intermediate walls of the furnace? Would it be a hard brick or an insulating fire brick? what provisions are made for replacing heating elements and refitting the walls?

E. J. Seabold: Mr. Horko's first question, "How would an operator know what the proper heat input should be?" It would not be necessary for an operator to know exactly what the proper heat input should be. The temperature control instruments for each of the heating zones in the first three heating sections are set at about 1850 F, then through the range of varying strip speeds, gauges, widths and strip temperatures, the reactor control instruments will automatically change the voltage, independently for each zone, to its proper value. In this way the desired temperature gradient between the heating units and the strip is maintained for either light or heavy gauge material. In answer to the second question, "How can an operator be sure the band is being heated in all passes of the furnace?" The speed of travel, for any particular gauge and width of band, is adjusted to the desired top temperature by observing an indicating and recording strip temperature instrument, actuated by a thermocouple suitably located at the end of the third heating section. Over the range of strip speeds, the operator can be assured of a continuous flow of power to the heating units, accurately adjusted to the immediate requirements of each furnace heating zone. This is important, because of the relatively short period of time the strip is in the furnace, about 13 seconds at 500 feet per minute. Constant power input as represented by the use of saturable core reactors, differs from the so-called ON and OFF controls that regulate power by alternately applying full voltage and no voltage to the heating units. With this type of control there is a possibility that sections of the strip within the coil may not reach the intended temperature, due to the short time in the heating sections and especially during an off period of one or more of the heating units.

The third question is, "What type of brick is used in the intermediate walls of the furnace and what provisions are made for replacing the heating elements and repairing the walls?" The intermediate walls of the furnace are 2600 F, light weight, insulating refractory brick. Heating elements and brickwork are repaired or replaced by access to the particular furnace section through doors located on the side near the bottom of the furnace shell. The heating sections are wide enough for a man to climb up and down for inspection and repair.

A. J. Fisher: In the production of strip, we prefer to use rimmed steel. This is our low-cost steel. The next step then is to make all the tempers required, which are seven in our case, from this steel. This can be done by suitable annealing and skin passing. In the harder range tempers, several phases through conventional skin pass mills are usually required. However, new skin pass mills have been developed which will make all the tempers in one pass, using rimmed steel in conventional coil annealing.

Now, in following Mr. Seabold's premise, the continuous furnace has a tendency to produce hard steel as against the batch process of soft steel. Therefore, this method of annealing is at the opposite end of the metallurgical hardness scale, the hard end. My particular question for Mr. Seabold is, how many of these various temper grades can be met with his particular type of furnace and would it be necessary to make the cooling stages longer to meet all the grades of temper, using conventional skin pass or recently developed skin pass mills and rimmed steel?

E. J. Seabold: As Mr. Fisher pointed out, present practice on rim steel is to anneal dead soft and cold work to customers requirements. In following this practice, to obtain final Rockwell hardness values of 58 to 64-B, the amount of cold work performed at the temper mills produces an elongated grain structure with longitudinal and transverse physical properties varying considerably. This type of material has well known disadvantages in fabricating, in addition to placing an unnecessary heavy load on the temper mills. The requirements for producing this material on strip furnaces, would be low temperature annealing and light temper pass, primarily for shape. The product resulting from this procedure will show a small equiaxed grain arrangement, which is conducive to better surface conditions, and with physical properties being very uniform in both directions. Continuous strip furnaces are, therefore, very well adapted to furnish tempers 1 to 3 as specified by the American Society for Testing Materials.

For temper 4, the Rockwell hardness specification ranges from 53 to 58-B. To meet this requirement, the top temperature of the strip in the annealing process, is raised to 1550 F, and the cooling from this temperature to about 900 F is considerably prolonged. This cycle of heat treatment differs from that of the present furnace installations, where with increased strip temperature, the cooling is correspondingly increased. That is why materials produced on these furnaces test at the hard end of the metallurgical scale and also, is the basis of the opinions that have been formed as to the suitability of strip annealed material, for the various uses to which it may be applied.

Specifications for temper 5 tange from 38 to 53 Rockwell B. Normally, when annealing 0.010 in. strip in the batch furnaces at 1250 F, soaking for 10 hours and then cooling to 300 F in approximately 40 hours, the Rockwell hardness tests will be somewhere between 46 and 52-B. Under conditions of light temper rolling the 52 may be held to a final 53.5 or 54. In order to compete with this material, in drawing properties, with short cycle annealed strip, it is necessary to increase the top temperature to 1725 F, which means reducing the speed of travel to 250 feet per minute or 7½ tons per hour output. This permits cooling at the rate of about 11 degrees per second after full annealing and can be compared to a cooling rate of approximately 150 degrees per second if this material were to be annealed on the present furnaces. The small uniform surface grain resists "orange peel" and the physical properties compare favorably with that obtained in the batch method. This is substantiated by the tests obtained and plotted in the curves of Figure 4.

It has been the experience of others as well as ours, that with short cycle annealed tin plate, many commercial articles have been made satisfactorily with

material of a higher hardness than that specified for the batch annealed product. However, to fully establish the usefulness of continuous annealed strip, it will be necessary, over a period of time, to tabulate data secured from the many stamping, forming and drawing operations and to readjust hardness values to agree with the performance of this new material.

A. M. Quinn: I heard the speaker mention a washing powder that is being used in the rolls. I would like to know the formula of the washing powder and volume used. I don't know whether the speaker can answer that question but I am interested in this point.

E. J. Seabold: An ortho-silicate is generally used. The requirements are about 8 lb of washing powder per ton of material processed.

Norman C. Bye: What would happen if there were two edge cracks close together, that is, if at the time of stopping for one fault there was a second edge crack between the cut-off table and the photo-electric cell, would the apparatus catch this second fault? Also, how do you thread this furnace, either originally or in the event that anything happens during this operation?

E. J. Seabold: The purpose of the photo-electric scanner is to relieve the operator of the task of constantly watching the strip for bad edges. The scanner will locate the first edge fault and stop the entry end of the line. From that point, the operator takes over and observes the strip. If a second edge crack appears between the cutout table and the scanner, the operator can slow down the furnace line, if necessary, to give him more time for inching the section to the cutout table, or the cutout can be made with a pair of curved hand shears while the strip is in the loop without inching the bad edge to the table. While working at the cutout table, the entry end operator controls the furnace line speed in so far as slowing down, stopping, inching, and resuming speed is concerned and is equipped with the proper controls conveniently located.

The furnace is threaded initially, when cold, with a 6 in. nicrome leader strip. With the furnace up to temperature and completely purged of air, this leader strip is used to pull the material through the furnace at the start of the annealing operation. In the event that the strip parts during operation, any section of the furnace can be re-threaded at high temperature as follows:

We will assume that the strip has parted in the most difficult place in the furnace, the outgoing strand in the heat-exchange section at point A. Further assume that the strip has dropped back over roll B and the momentum of roll C has carried the strip over the top and down, as indicated in Figure 5.

Normally, parting of the strip due to bad edges would occur in the incoming strands or in the heating sections, which are considerably easier to thread. Bad edges that may possibly get past the scanner, due perhaps to electrical failure, are intended to part the strip in the entry looper where the strip tension is greater than in the furnace strands. However, in the event that it does happen, the following is an outline of the necessary steps to rethread the furnace.

The furnace line is considered to be running in normal operation.

What happens:

a. The strip parts.
b. Furnace rolls slow up.
c. Master pinch rolls throw slack ahead.
d. Rider arm D drops—emergency stop of the line.
e. Heating elements automatically drop to 5 per cent of capacity.

What to do:

a. Block rider switch in closed position and set up the line controls for inching.
b. Inching the overhaul pinch roll unit, without a movement of the strip at the entry roll seals, will indicate that the strip has parted.
c. Disconnect the heating elements from power.
d. Change combustor to inert gas ratio and raise to maximum volume.
e. Open valve on vent line to indicate a slight positive furnace gas pressure.
f. Hook up gas bomb to the last cooling chute section.

Locating the break:

a. Check for possible break in the cooling chutes, by slight inching of the overhaul pinch roll unit and check for a movement of the strip with a small rod through the opening at E. If the strip moves, assume then that the break is in the furnace.
b. Doors in the heating section may be opened immediately for check in these sections only. Close up tight if the strip is okay. One quick glance should be sufficient; too much air in these sections will cause the strip to burn off.
c. Peep sight F at the entry side of the furnace on top, will permit a view of the outgoing strands over to the intermediate wall. Peep sight at the opposite end will allow a view of the remaining outgoing strands. Peep sights in each of the bottom furnace plugs provide a check point for each of the incoming strands.
d. Through peep sight F, no strip is observed on rolls B and C.
e. Only after developing an inert gas at the last cooling chute section—by checking with the gas bomb and laboratory tests for CO and CO_2 content, can the doors in the heat-exchange section be opened. When okay, shut down the gas machine.
f. Door G locates one end of the break and doors H and J are opened to locate the other end.

Rethreading:

a. Remove bottom plugs K and L. See Figure 5.
b. Inch slack into incoming strands with the master pinch roll unit.
c. Pull incoming strip at point M, out through opening K and spread out on the floor.
d. Pull incoming strip at point N, out through opening L and spread out on floor.
e. Remove excess strip from outgoing strands through openings K and L, cut off and spread back.

f. Insert threading pipe over top of roll B as shown in Figure 6. Feed the nichrome wire with weighted end through the pipe until it rests on the top of the roll, turn the roll counter-clockwise and continue to feed the wire to descend on the entry side of the roll. Feed the other end of the wire through the pipe and turn the roll to drop the wire on the discharge side of the roll. Weights will appear at opening K and door H as shown in Figure 5b. Repeat this procedure over roll C and weights will appear at opening L and also at door H.

g. Insert rod through opening K to door H and pull wire down through K on the proper side of the roll shaft. Pull both ends of each wire down to pull the loops through the threading pipes and on to the top of rolls B and C. Splice the wires and pull the loop back to door H. Center the loop on the roll with rod.

h. Attach nichrome leader strip, with sheet section attached, as shown in Figure 7, which will prevent the leader strip from twisting, to wire at opening K and pull through to opening L. Spot weld the sheet section to the end of the outgoing strip that extends through opening L of Figure 5.

j. The other end of the leader strip has a sheet section attached as per Figure 7, so spot weld this to the section of outgoing strip that extends through opening K. The arrangement of strands is now as indicated in Figure 5c.

k. Inch the overhaul pinch roll unit to pull the outgoing strip taut. Continue to inch to pull the incoming strands taut. Center the strip on the rolls.

l. Close up all furnace doors, plugs, and pipe sleeves.

m. Connect heating elements to power and restart gas machine on reducing ratio.

The line may be started at this time and run at a slow speed until the strip is bright, for material that is to be white pickled prior to hot-dip or electro-tinning. The strip should brighten up in about 20 minutes. However, if a bright strip is desired from the start, the regular leader strip used to thread the furnace on scheduled shut-downs is attached in the following manner:

Threading the regular leader strip:

a. Remove the section of trench plate and cut the strip at point P. Spot weld to the sheet section attached to the leaded strip. This leader strip feeds from a mechanically braked portable mandrel Q, down around roll R and up through the entry roll seals. The back tension is sufficient to maintain tracking of the strip on the rolls. Floor lugs hold the mandrel in place.

b. Inch the overhaul and coiler pinch roll units as required to pull the leader strip all the way through the furnace. Spot weld the other end of the leader strip to the section of strip in the strip trench.

c. Place the mandrel Q at the discharge side of the coiler as shown in Figure 5 to receive the leader strip on starting up.

d. Start the line when lab tests indicate a reducing atmosphere in the last cooling chute section.

Total shutdown time including purging for a bright strip would be about four hours for this type of break. The incoming strip would take approximately three hours, and the heating sections about two hours, as no purging is required.

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BUFFALO, NEW YORK

▲ DIE ROLLING is the process of rolling a string of blanks, each of which has varying cross sectional area produced by heavy reductions, and specified center to center length. When sheared to length blanks are of identical shape.

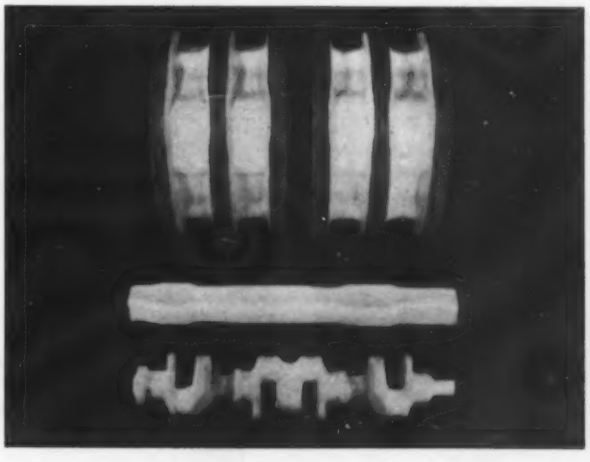
The idea is not new. Years ago pamphlets were issued showing and describing the rolling of such articles as coins and keys. I do not remember why the idea was abandoned or if it attained reasonable success, but in any event the patent office can furnish you at nominal cost the copies of some 87 patents issued between the periods of 1865 and 1920 covering the rolling of such articles as wagon or freight car axles, bicycle spokes, horse shoe nails, buggy steps, chain, and other sections. It was intended to roll these articles finished and ready for use. The patent papers describe the roll setup and show numerous passes in one stand of rolls that the inventor claimed would produce these articles. Ridiculous as they seem, these claims agree closely with our original ideas when in 1920 we started die rolling on a 14 in. hand mill in the Pittsburgh district.

Our first objective was to find articles that were being used in large enough quantities to justify roll cost. There were numerous articles such as tie rods and wagon hardware made by a flattening operation where some sections were round and the reduced sections were flattened to a size that equalled the natural spread of the leader.

As the automobile was changing from a rich man's toy to a necessary means of transportation, our efforts naturally turned to this field where many duplicate forgings would be required. The first articles tried were rear axles and drive shafts and results of early trials were very disappointing. This is when we discovered there were definite rules that must be observed and followed if we were to be successful. Our first rolled article was a transmission drive shaft, 52 in. long, which rolled 3½ in. over specified length. The largest diameters were fairly round, but the reduced sections were egg shaped, and there was an overfill or flash along the reduced section of the bar. The length was corrected by shortening the groove and the out of round condition by reducing the groove depths at points of heavy reduction, but the flash had us puzzled. We could not get rid of it so it was decided to allow for the formation of flash and later remove it by trimming. A careful record was kept of all rollings and graphs were made showing size and shape of leader bar used, reductions from the leader at points of heavy reduction, length of bar between these points, lengths of groove used, speed of rolling and temperature. We were successful in rolling rear axles and during the following 10 years furnished some 23 million of them to the trade.

Our next attempt was a front axle. This axle had a rolled I-beam center which, after flash removal, required no further finishing operations on the beam section. Sufficient stock was properly placed to permit

Figure 1 — Complicated shapes such as crankshafts are easily made by die rolling. The top of the photo shows the rolls, the center shows the blank and on the bottom is the finished crankshaft.



Presented before AISE, Annual Spring Conference, Chicago, Illinois, May 6, 1946

the forming of spring pads and king pin bosses by subsequent forging. New graphs were made covering these blanks, as it was learned that the results obtained from a round section rolled from an oval leader, could not be used to figure groove lengths and roll spring for beam and rectangular sections rolled from a rectangular or rudimentary leader.

After getting the front axles into production, we next tried and produced gear shift levers, ring gear blanks, wheel spokes and brake pedals. During this period from 1920 to 1930, 1095 estimates were made and 277 different articles produced.

Up to this time, we had produced 197,000 tons of die rolled articles on this 14 in. hand mill with a die roll stand that was driven by a 500 horsepower, 285 rpm motor, through a gear reduction having three spindles. The motor was constant speed, so that the only way to change the speed of the mill was to move the die roll housing from one spindle to another, or from 27 rpm to 68 rpm, or to the third spindle at 108 rpm. This did not permit desirable speed control. Early in 1930, this mill was abandoned and all work transferred to a 14 in. mill

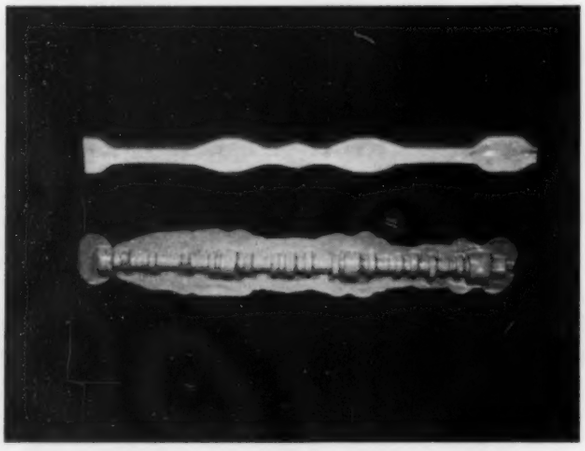


Figure 2 — Cam shaft and press forging.

at Buffalo. This mill had a die rolling stand driven through a gear reduction by a 1000 horsepower motor which varied in speed from 210 to 510 rpm. With the new setup, we secured better length control with a corresponding improvement of quality.

If die rolling was to continue, more tonnage was needed and we investigated other types of articles such as crankshafts, camshafts, connecting rods, support arms and steering arms. At that time, these articles were forged from bar stock. We realized that if we were to get any of this business, a flashless blank would need to be developed. The line left on our rear and front axles after flash removal gave no trouble in machining because it was carefully ground, and the flash formed in rolling was in the same plane as that formed in forging in the hammer dies. These new sections would require rolling and edging in the hammer dies and a flash rolled blank unless closely trimmed and carefully ground, would show defects in the finished article. A forging requires a definite amount of steel to fill the die impression with sufficient flash to insure an article free from cold shuts. It does not matter whether this steel is in the form of a billet, bar or die rolled blank, as each will make a good forging if properly worked, but bars and billets will require more hammer work than will die rolled blanks.

In 1931, we developed a flashless blank which could be forged in any plane because it had the same smooth surface on all sides. It was well received by the forge men, for, by its use, hammer production was increased as much as 60 per cent and die life 300 per cent. Due to its irregular shape, it did not pack solid in the heating furnaces and permitted a circulation of hot gases and more uniform temperature in a shorter time. By saving time and hammer work, the blank arrived at the blocker and finisher impressions at a higher temperature, thus saving die wear. Scrap loss was reduced to a minimum.

During the following 15 years, over 1,000,000 tons of die rolled articles were produced. During our greatest month of production, we turned out approximately 1,300,000 pieces or 18,500 tons. In our greatest single day 44,873 pieces were finished and made ready for shipment. It might be argued that automobile production was on the upgrade during this period and that such an increase in tonnage was to be expected. That was not the reason. We had an article the trade wanted, which was sheared to length, increased production, reduced scrap loss, and saved costly die life.

Die rolling differs from ordinary rolling mainly in the finishing or die rolling stand. This stand must be rigidly constructed with extra long windows to permit the use of rolls of varying diameters; it must have special fixtures such as chucks, liners and mandrels to accommodate various sized rolls. The process also requires a separate motor of variable speed; a gear reducer, pinions and universal couplings connecting pinions and rolls, and a timing device preferably on the mill end of the top pinion to permit the setting of the top roll in proper registration with the bottom roll.

DIE ROLL DESIGN

Flash blank — To lay out a roll for a flash blank we use a design of the article which has been made from the customer's finished print or sample. This design roughly resembles the finished part but allows stock for finishing when a part such as a rear axle is to be machined only, or additional stock for hammer flash if the article is to be forged. This print is figured to hot size to allow one sixty-fourth of an inch per inch for shrinkage. Sections to the hot dimensions are developed at points where there is a change in area or contour. Reduction of these areas from the leader bar are computed and the groove lengths measured on the face of the roll. Sections of the blank having the largest area, usually 16 to 20 per cent less than the leader bar, will require a groove somewhat longer than the bar rolled as there will be a slippage of the roll on the bar when this particular part is passing through the mill. This we call contrusion, and for a section running from a large area of small reduction to a small area of large reduction the groove must be shortened somewhat as there will be a forward slippage or extrusion of the metal ahead. A small straight section of large reduction

will also produce a forward slippage of metal, but not to as great an extent as in the previous case. Slippage will vary with the length of the section. At the start of the section, the rate of slippage which we call extrusion is large but is reduced at a uniform rate per inch as the length of bar increases, although it does not entirely disappear. In rolling from a large reduction to a small reduction, we again have a slippage of the roll on the bar, or contrusion, and the groove length will be longer than the bar. This slippage will also vary with the size of the bar rolled. The larger the bar, the less the slippage.

In laying out a rear axle, we design the rolls so that the largest end of the long tapered section enters the pass first and rolls, as we say, down the long taper. In a small axle, the groove length will be as much as one and one-half inches shorter than the bar length, but in a larger axle, that is one with a larger weight per foot, but the same per cent reduction from its leader, the extrusion will be much less. The flash formed on both sides of this reduced section has a direct bearing on maintaining length, the thinner this flash, the more the extrusion. The flash starts to form when the roll grips the bar ahead of the rolling center and since the roll groove, at points of great reduction, are always narrower than the leader bar, the flash is ironed between the roll faces. The thicker the flash, the less friction you have and therefore a less forward slippage. This is very easily proven as follows: When the blank is heavy and the volume of flash is large, we cut a 10 degree bevel at a point one-quarter of an inch from the groove edge to protect the edge of the groove and get greater groove life. This reduces the pressure, eases the friction, and will shorten the blank $\frac{5}{8}$ of an inch in 20 inches. Roll size will affect spread and must be considered in layout. Speed, temperature, the size and shape of the leader bar will also affect length but these are variables that exist during any type of rolling and can be readily adjusted. A gate section of $1\frac{1}{2}$ to 2 inches is included in length figures to permit redressing of rolls and take care of length variations from front to back of a string of blanks. With rear axles where two blanks are laid out in one turn of the roll, this gate permits a transition section from the larger spline end of one blank to the smaller wheel end of the following blank. The sum of the groove lengths, plus gate, divided by π, give you the outside diameter of the roll and this diameter is furnished the roll shop so that rolls can be turned ready for layout when roll drawing is completed.

Groove depth — In all forms of rolling there is a roll set provided to take care of mill spring, but in parallel rolling the pressure is uniform; whereas in die rolling, due to change in pressure at points of great reduction, the spring is constantly changing. To overcome this widely varying pressure, we reduce the groove depths at points of great reduction. The amount of spring will vary with a given mill, but once established, it can be considered constant for that mill unless the mandrel size is changed, and even then it will be almost too small to consider. The same rule does not hold good for spring as for extrusion and contrusion. Extrusion and contrusion decrease as bar size increases but spring is exactly opposite. The larger the bar, the greater the spring, and the smaller the bar the less it will be.

The setting of the rolls governs the flash thickness.

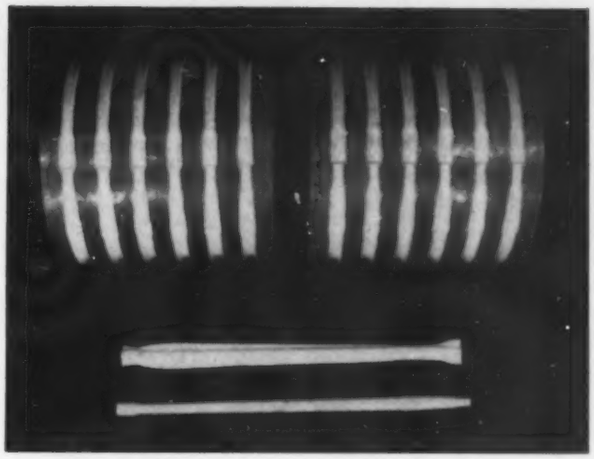
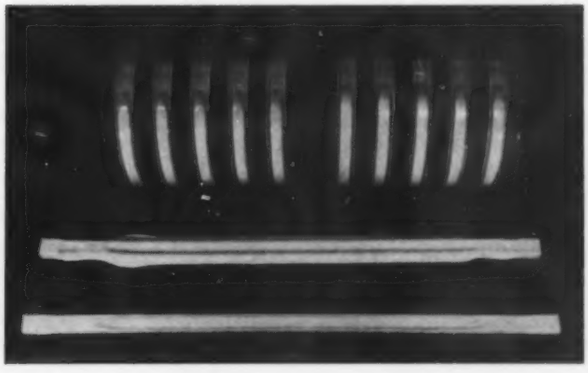


Figure 3 — These rolls are designed to form the rear axle shown in the center. On the bottom, the axle has been trimmed.

The figured spring plus roll set is subtracted from the hot height, and one-half of the result is your groove depth. This is figured for each particular section because the per cent reduction from the leader bar to each section will be different, and the spring will change at each point. When a roll drawing is finished it will show roll diameter, direction of rolling, groove lengths and groove depths, and roll set. When the drawing is received in the shop, the layout man makes templets of each section shown on the drawing and also of each short transition section. Six different men may be working on one set of rolls so it is essential that all templets be as accurate as possible.

The rolls, consisting of two sleeves are mounted on a mandrel side by side. This mandrel is of the same diameter and uses the same size of keys as the mill mandrels. The layout man scribes the outline of the blank around roll periphery, laying out both rolls in the same direction. If number one groove in the first roll is carefully laid out for length, these dimensions can be transferred to all other grooves by use of a straight

Figure 4 — The rolls for forming a front axle are shown in this view, with the untrimmed axle in the center, and the trimmed axle on the bottom.



edge, however, connecting these points and marking the outline of the groove width is required for each separate groove. After rolls are laid out, an arrow showing direction of rolling is cut in the opposite end of each roll, and one roll is marked top, and the other bottom roll. If the top roll is now turned upside down and placed directly above the bottom roll, both rolls will be in correct position for rolling.

After layout, the rolls are placed in a lathe where the smallest section which we term the lead groove, is cut for each pass. Rolls are now placed in milling machines, either horizontal or vertical, depending whether the sections are of a cylindrical or a rectangular shape, and the impressions are cut as laid out. Templets are used to insure proper depths and contour. After sinking, the grooves are ground to remove all tool marks. They are next returned to the layout table for final inspection and correction of any mismatching at transition sections. To give you an idea of precision required, in one type of gun barrel, there were eight grooves in each roll, and each groove had three barrel impressions in roll periphery. The 24 impressions in the bottom roll had to be identical to the corresponding impressions in the top roll to produce articles that were exact duplicates of each other.

Flashless blanks — Rolls for the flashless blanks are processed similarly to the flash rolls. That is, you use extrusion and contrusion in computing groove length, and roll spring for heavy reduced section. As stated before, in rolling a flash blank, any variation in flash thickness will be reflected in bar length. However, in a flashless blank where the bar is entirely within the groove at all times, your groove length governs the bar length produced, and you have very little variation in length of blanks from front to back of a particular string. Therefore, these blanks have no gate section except where the small end of one blank connects with the large end of the next blank which rarely happens. In fact, we have only two articles where this occurs, and in laying out a blank you have plenty of leeway to prevent it. Blanks must have a tonghold to enable the forger to handle the article and except in extreme cases, you can make this tonghold conform in shape to the adjacent section. In other cases when lengths will permit, and an equal number of blanks are sunk in roll circumference, you can match up similar sections by reversing every other blank. You can vary the length of a flashless blank by altering the leader bar, but in doing so you increase or decrease the weight and care must be taken to prevent rolling of articles which have insufficient or excess stock for the customer's dies. The leader bar in this type of rolling is always smaller in width than the groove, and is so designed in conjunction with the die roll groove that the maximum spread of the smallest area will not overfill the groove. The shape of the groove section of greatest reduction helps retard spread, but will not prevent overfilling if leader bar is too large. In flash rolling, it is common practice to roll as high as a 78 per cent reduction from the leader bar, but in flashless rolling 48 per cent is the largest we have attained, and this only under ideal conditions. The variables you must contend with in figuring possible spread are shape, size, steel analysis, roll diameter, speed, temperature and length of reduced section. This is not as bad as it sounds for in designing the blank, you have considerable control over these conditions. Experience with forge shop practice is a great asset in deciding shape and size. If a roll is designed to produce a blank to the maximum length tolerance, it can be used until the bottom tolerance is reached and will require very little redressing as the groove edges are not broken down as in flash rolling. When the reduction is too great for rolling, the blank can be shortened to reduce this reduction by increasing the area of the smallest section. Since the object is to reduce hammer work, you must take all reduction possible and try to keep the length as near to that of the finished article as you can.

Flashless rolls are laid out, the lead groove cut on a lathe and impressions cut on milling machines in the same manner as flash blanks. Templets are used to enable the die sinker to work to exact size and rolls are ground and rechecked for accuracy. On completion, rolls are stored in the die shop until called for by the mill. When rolls are requested by the mill, the shop superintendent estimates from the mill lineup sheet the number of rolls required to produce the specified tonnage and sends them to the mill. On arrival, the rolls are mounted on the mill mandrels. The keys in these mandrels are located in proper relation to the butterfly on the driving end of the mandrels, and will set the rolls very nearly to exact registration for rolling when placed in the housings. Any variation in registration, or timing as we term it, is corrected by adjustment of a timer on the end of the top pinion. This timer consists of two sets of backup wedges which turn the top roll either forward or backward, and can be locked in position when rolls are in exact time or correct relation to each other. Cross rolling is corrected by moving either roll laterally, the same as in parallel rolling. The mandrels are connected to the pinions with universal couplings. Both rolls are driven. A gear reduction and a variable speed motor gives us from 25 to 60 rpm. The die roll mill, as stated previously, is of rigid construction and will accommodate rolls of from 16 to 32 in. in diameter.

The mill that feeds this die roll stand is a 14 in. cross country mill with seven stands and 9 passes, the last stand is removed when the die roll stand is in place. Tons per hour on large sections are limited only by furnace capacity. The uniform leader bar produced by the 14 in. mill is entered into the die roll stand and emerges as a string of identical articles which, depending on type, may be shipped directly after shearing to length, or may require annealing, flash trimming, grinding and straightening. All blanks are carefully inspected.

Much has been written about the rolling of steel and while results of extensive experiments have been tabulated, about all they prove is that certain forces do exist. Practice does not confirm with theory except when the section is rolled under given conditions on a given mill. Tangential forces, angle of entry and other such factors may have their place in straight rolling of uniform cross sections, but in die rolling each article presents a special problem. Having successfully rolled over 600 different articles we feel confident that die rolling is here to stay.

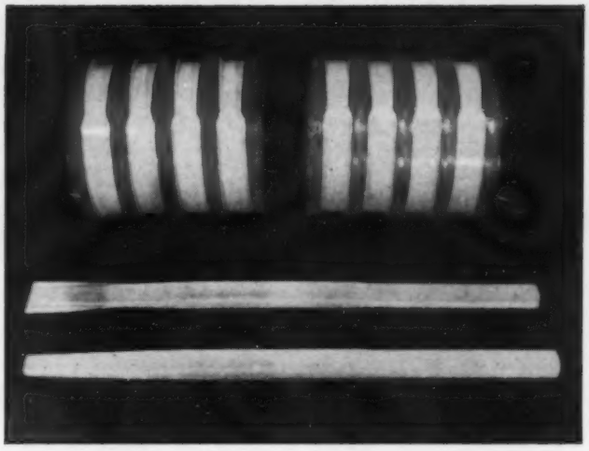


Figure 5 — These die rolls are used to form a light plow beam.

DISCUSSION

PRESENTED BY

T. N. SLOAN, Die Roll Engineer, Republic Steel Corporation, Buffalo, New York

C. P. HAMMOND, Superintendent Rolling Mills, Atlas Steels Limited, Welland, Canada

W. FIELDS, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

LOUIS MOSES, Superintendent, Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland

H. F. MARQUARDT, Superintendent of Rolling, Republic Steel Corporation, Buffalo, New York

C. W. BARRETT, Roll Designer, Republic Steel Corporation, South Chicago, Illinois

Member: I would like to ask the author his opinion of using an alloy steel roll on the finishing pass, and what material they used back in there? Also, due to the amount of tonnage you can get out of the pass and the slip, what will happen when a pass with an alloy steel is rolled?

T. N. Sloan: We get better results from an alloyed iron roll than we do alloyed steel. We originally rolled the Ford axle on alloy steel rolls. It cost about 36 cents a pound. The rolls required heat treating, which consumed about three days longer to manufacture, but during the war no steel was available and through necessity, we had to find another material. The roll manufacturers worked with us and we now hammer die mixes of several different types. With these we have doubled the tonnage on the passes and get much better articles from the rolls. The rolls are easier to make, and the cost is considerably less. However, when we have an article like the old Ford front axle, where we can only get one blank in the periphery of a roll, 17½ inches in diameter, with bore of 10½ inches, a cast roll does not stand up and we must use a steel roll. Otherwise, from 18 inches and up on this same job, we use the alloyed iron.

C. P. Hammond: When you are selecting a roll diameter to roll a comparatively small section, do you take the minimum diameter required to make one or two blanks and take advantage of the least amount of spread, or do you select the larger diameter in order to get the greater number of blanks?

T. N. Sloan: That question presents a good many variables. It is an advantage to have a small diameter roll, naturally, in order to keep down the spread. If the bar is large enough to give you good tons per hour, when the bar is small, and too light for a 14-inch mill, we have to sacrifice mill production in order to produce them. We did put four and five blanks in the circumference and found that the increased speed also helped reduce some of this spread. Therefore, the larger rolls with greater delivery speed, offset some of this spread, but when you figure the blank out originally for flashless rolls, you have to take that into consideration and you will find different ways you can get around it. You can shorten it, as for example with a connecting rod, where it is impossible to roll a blank the length of the die because the actual reduction is up to 90 per cent. We can't do anything like that in flashless rolling, and when it is shortened it doesn't make a great deal of difference to the customers.

C. P. Hammond: In regard to contrusion, should the area of the larger part of the section be less than the leader, and is there a constant that can be used that will determine the length of the groove in proportion to the draft?

T. N. Sloan: As I stated before, when we started making these flash rolls, we kept accurate records of everything that was done and compiled charts. These charts were used when we had a new section to estimate. The chart has a definite leader for the section. For extrusion, we divide the chart leader by the leader of the bar we are going to use at the present time. That will give us a ratio or per cent of reduction which we multiply by the chart reading. We will adjust that chart to our new leader and that is also true for the spring, except that you divide your new leader that you are now estimating by the chart leader. When the chart area is less, your spring will be greater, but we don't have any definite ratio that we can use arbitrarily. We must go back to our original charts and use the ratio we get between the chart leader and the leader we intend to use for the section being developed.

T. N. Sloan: In the crankshaft the groove becomes shorter. It is not worn out but becomes shorter due to wear. The per cent reduction runs about 40 per cent. We hold them to the tolerance and have plus or minus one-quarter inch. We have rolled 26,000 tons or better. With the smaller articles such as connecting rods, we have more grooves. There are six grooves in the roll and we get almost as much tonnage. The flash articles, of course, break down the grooves much quicker. Eighty tons is about all we will get out of a groove without regrinding, and to keep the shape of a Ford axle, you can grind the rolls just once. However, we can always rework that roll, and when we cut the diameter and shorten the length of the groove, by reducing the flash, it enables us to get increased length on the bar. We cut that roll almost one inch in diameter before it is scrapped.

W. Fields: We have also experienced this effect of contrusion, or shortening up of a bar. I would like to ask why contrusion occurs? It occurs sometimes under

rather heavy drafts. Also, Mr. Sloan mentioned that the rate of slippage is reduced as the rolling progresses. Does that mean that the rate of slippage is reduced from the front end of the blank to the rear of the blank, or from the front of the bar to the rear of the bar, and why does it occur?

T. N. Sloan: Mr. Fields' first question is one that is rather difficult to answer except with personal opinion. Naturally, when you have little pressure, that is, where your reduction is very light, it would be natural to slip, and then as your groove tightens, and your reduction increases, the steel must go some place, and we have found it goes forward. I have tried to determine if the bottom of the groove doesn't have a direct relation to the length of your bar, especially in sections of small reductions from 10 to 20 per cent, but I have never been able to satisfy myself that was so.

Now, there are two answers to the second question. There is a variation in the length of the straight bars from front to back. We roll our bars from ninety to a hundred foot in length, and the front end will vary in a flash blank. It will be shorter in the front than at the back. In a flashless blank, there will be hardly any difference between the front and back, about a thirty-second of an inch. But, in rolling a small reduced section, say of four inches, you will have a greater extrusion in that four inch length per inch than you will have in a six inch length per inch. The steel apparently gets what you might call set, after it once hits, and you will notice that in the variations of your flash. You can determine in which direction a bar has been rolled by looking at the flash line. After the roll has hit the leader bar, the flash comes out, and then if you look, you will see the flash narrows down and holds a straight line throughout and there is a variation in the extrusion at that point. What causes that, I can't definitely say.

Louis Moses: The earliest example of die rolling coming to my attention was done on a two-high 16 in. mill at Johnstown, Pennsylvania, where tradition has it that prior to 1890 a horseshoe bar was rolled. After cutting to length, and bending, the rolled projections formed the heels of the shoe. It is not recalled whether a pad for the toe caulk was formed also. It probably was. Large tonnages of railroad tie plates are made with transverse ribbing. A single shear cut divides the rolled blanks into individual finished lengths. For this reason, the spacing of the blank impressions around the circumference of a constant speeded mill creates a vital factor to be met. It is noted that speed control is mentioned by Mr. Sloan as a requisite to rolling his products.

Etching of cross-sectional portions of forgings show the lines of flow taken by the metal's particles during forming. These flow lines are a cause of concern to metallurgists who must account for the success or failure of the bar material furnished. Sharp concentrations of flow lines are sometimes suspected as the cause of failure and efforts are made by all concerned in the matter to streamline metal flow. Can Mr. Sloan tell us what influence a die rolled blank has on flow lines in the completed forging?

T. N. Sloan: I don't know if Mr. Moses meant the first of his remarks as a question or not. We rolled these so-called horseshoe blanks and we have had quite a little experience with them. We found that the best results were obtained by having different diameter rolls. You increase the diameter of the opposite roll three times the amount, you dress the other roll, that is, if you reduce the top roll in dressing $\frac{1}{32}$ in., you have to increase the bottom roll $\frac{3}{32}$ in. to hold length. In our method of die rolling, we roll on equal diameter rolls in all cases and don't depend on slippage or what I would term almost guesswork. I investigated the rolling at the Youngstown plant of the Carnegie Corporation, where there is a library. The man who had the library for twenty years had rolled everything of the wagon hardware type that you could possibly imagine. He had more roll combinations there than a man could ever use. We have eliminated all that and have come down to definite figures whereby we can go in and know what size roll we are going to need and what we are going to get from that roll. We don't use guesswork.

Now, in regard to the flow lines, die rolling does improve the flow lines, that is, you have flow lines throughout the article. You can take a forging and split it and tell whether it has been die rolled or made from bar stock. In our flash rolling where we do have a breaking of those flow lines along the flash line, the majority of them are improved by the finishing of the article. All our experience has proved the die rolled article superior to bar stock when made of the same type of steel.

H. F. Marquardt: We now have at least three large steel makers who are licensed by Republic to do die rolling, and I wish to impress upon you people, who don't know or who haven't heard much about die rolling that it is not just a novelty. We have made, during the war, over seven million blanks for guns, from the Garand up to the 60 caliber machine gun. To date, and I am making a guess, probably a million and a half tons of steel have been processed, that were die rolled by ourselves and other steel makers. That would amount to about two hundred and fifty million blanks.

When they introduced die rolling to our plant, which had always used conventional methods, I thought the reductions would be impossible to make. However, I found out that I was wrong and that one can do many things with a set of die rolls, which the conventional mill man never thought possible.

C. W. Barrett: If you are not at all times able to identify contrusion and extrusion in your original design, can you control that in any way by the speed of rolling on your mill?

T. N. Sloan: You can govern the length of your bar by speed, yes, but if you mean the over-all length of a bar, which probably has seven different sections, about half of them will be extrusion and half contrusion while others will be like a neutral section with not much of either. Then, you would be in trouble, for you would have to design your bar and have correct figures, because the over-all length of your bar isn't always the answer. You can have your spring pads too short, with not enough stock in it, or your end section may be too long, or the beam section too long, which would throw your spring pads out of place in the forging die. It is a rather difficult question to answer, because you can change the over-all length of the bar and if you want to use a little bit of temperature, that will also help you out. The fact is, as a rule, the faster you roll, the shorter it will be; and the slower you roll, the longer it will be; and the hotter the bar is, the longer it will be.

Sulphuric Acid from Coke-Oven Gas

. . . . in most cases, a hydrogen sulphide concentration of 450 grains per 100 cubic feet of raw gas will make the manufacture of sulphuric acid a profitable venture . . .

by W. A. Leech, Jr.

ENGINEERING AND CONSTRUCTION DIVISION

KOPPERS COMPANY, INC.

and F. D. Schreiber, GENERAL SUPERINTENDENT

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▲ IN 1802, the house of William Murdock at Redruth, Scotland and the plant of his employers, Boulton and Watt, were lighted by coal gas. In 1809, Clegg was using milk-of-lime for the removal of sulphur compounds from coal gas.

The reactions in this process during purification are:

$$Ca(OH)_2 + H_2S \longrightarrow CaS + 2H_2O \quad (1.)$$

Milk-of-lime — Hydrogen sulphide — Calcium sulphide — Water

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O \quad (2.)$$

Milk-of-lime — Carbon dioxide — Calcium carbonate — Water

Presented before AISE, Birmingham Session, Annual Meeting, September 17, 1945, and Cleveland Session, Annual Meeting, October 3, 1945

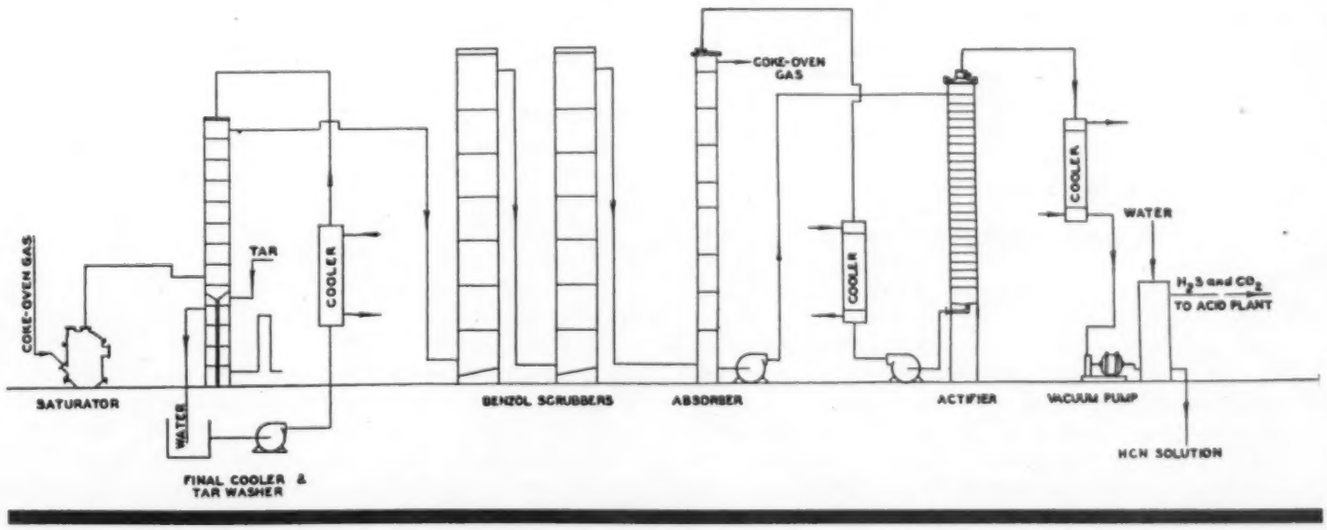
$$Ca(OH)_2 + 2HCN \longrightarrow Ca(CN)_2 + 2H_2O \quad (3.)$$

Milk-of-lime — Hydrogen cyanide — Calcium cyanide — Water

All of these reactions consume the milk-of-lime and none is reversible so that as soon as the lime is used up, it must be discarded and replaced. Control is difficult because as the lime is used up it begins to absorb carbon dioxide and actually release hydrogen sulphide. This continues even after disposal when it absorbs the carbon dioxide from the air and continues releasing hydrogen sulphide, making the disposal problem a difficult one.

The milk-of-lime process was the first-known gas-purification process and from the date of its introduction to the present time, there has been a continuous

Figure 1 — Flow sheet of hot-actification sulphur recovery plant used to recover H_2S and HCN from coke oven gas.



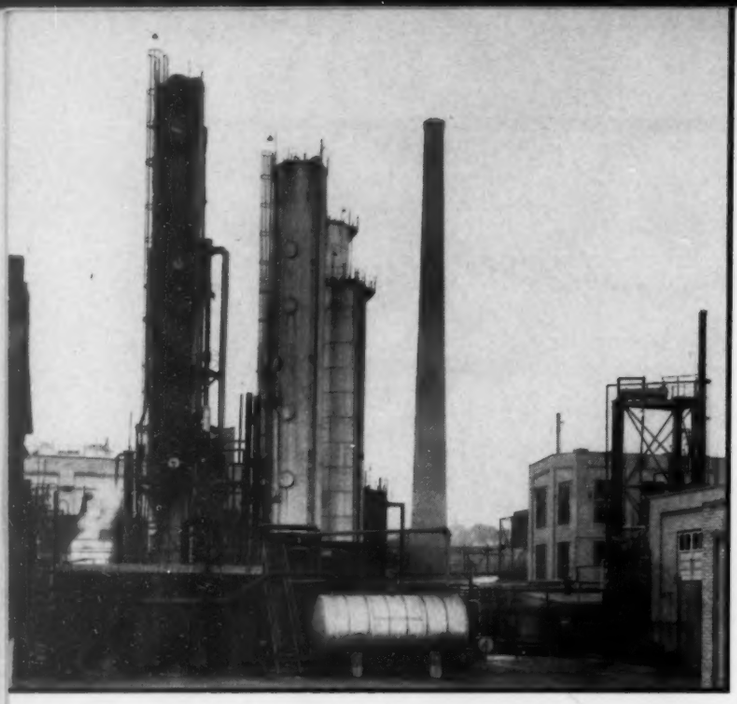


Figure 2 — General view of hot-actification sulphur recovery plant at the Pittsburgh Coke and Chemical Company.

effort by gasworks chemists to develop processes more efficient, less expensive, requiring less labor and, if possible, utilizing the sulphur removed from the gas, at a profit.

In the United States, the development of the by-product-coke oven, introduced in 1892 as an adjunct to the soda and ammonia processes, has been very largely aimed at the production of blast-furnace coke, and the gas produced, generated largely by carbonization of the low-sulphur coking-coals of the Appalachian region, has been low enough in sulphur concentration to be usable for nearly all steel-mill purposes without removing the hydrogen sulphide.

At the present time, our reserves of high-grade coking coal with low sulphur-concentrations are becoming rapidly depleted and the steel industry is faced with the problem of operation on the higher-sulphur coals. Part of this problem, so far as it is reflected by high hydrogen-sulphide concentrations in coke-oven gas, may be solved by gas purification. For this purpose we believe the process best fitting the by-product coke-oven plant serving a steel mill is one which will not only purify the gas as much as necessary for mill purposes, but also recover the sulphur as sulphuric acid for use in the plant and mill, together with any other useful by-products which may be sold at a profit.

IRON OXIDE PROCESS

In cases where the coke-oven gas was sold to public utilities for domestic distribution, the methods of the gas-utility industry were utilized for sulphur removal. For many years these were confined to the use of iron oxide mixed with wood shavings to provide a loose material through which the gas could pass without a prohibitive loss in pressure. This process was patented in England by Laming and Hills in 1849, and about 1870 the first iron oxide purification process boxes were built in the United States. In this process the main reactions are as follows:

Purifying

$$Fe_2O_3 \cdot x\,H_2O + 3H_2S \rightarrow Fe_2S_3 + (x+3)\,H_2O \quad (4.)$$

Ferric oxide — Hydrogen sulphide — Ferric sulphide — Water

$$Fe_2O_3 \cdot x\,H_2O + 3\,H_2S \rightarrow 2\,FeS + (x+3)\,H_2O + S \quad (5.)$$

Ferric oxide — Hydrogen sulphide — Ferrous sulphide — Water — Sulphur

and Revivifying

$$2\,Fe_2S_3 + 3\,O_2 \rightarrow 2\,Fe_2O_3 + 6\,S \quad (6.)$$

Ferric sulphide — Oxygen — Ferric oxide — Sulphur

$$4\,FeS + 3\,O_2 \rightarrow 2\,Fe_2O_3 + 4\,S \quad (7.)$$

Ferrous sulphide — Oxygen — Ferric oxide — Sulphur

Three types of processes for recovering sulphur from spent iron oxide purifying material were developed. The sulphur may be recovered as sulphur dioxide for sulphuric acid production by roasting the spent oxide, or it may be recovered by solvent extraction, or by distillation. Much of the development along these lines was continental and English, and wide use of the processes in the United States has never occurred. This is partly on account of our comparatively cheap and unlimited supply of sulphur from the Gulf coast, and partly because attention has been distracted from these possibilities by the inception of liquid absorption processes which operate basically with a lower pressure drop and a lower expenditure for labor.

THE SEABOARD PROCESS

One of the early processes of this type is the Seaboard process, which removes hydrogen sulphide from gas by absorption in a dilute solution of sodium carbonate. The solution is regenerated by desorbing the hydrogen sulphide from the solution in a contact tower in contact with a large stream of air.

The primary reactions involved in this process are:

Purifying

$$Na_2CO_3 + H_2S \rightarrow NaHS + NaHCO_3 \quad (8.)$$

Sodium carbonate — Hydrogen sulphide — Sodium hydrosulphide — Sodium bicarbonate

and Actifying

$$NaHS + NaHCO_3 \rightarrow Na_2CO_3 + H_2S \quad (9.)$$

Sodium hydrosulphide — Sodium bicarbonate — Sodium carbonate — Hydrogen sulphide

The reaction proceeds in the direction indicated in equation 9 when the solution is contacted with a large flow of air or other gas or vapor.

The limitations of this process are:

1. There is no recovery of sulphur.
2. Side reactions consume soda ash.
3. Disposal must usually be provided for the hydrogen sulphide bearing effluent air.

In spite of these limitations, this process is still the cheapest means of removing up to 95 per cent of the hydrogen sulphide from fuel gases where the expenditure for equipment for sulphur recovery is not justified, and where a simple and satisfactory method for the disposal of the effluent air may be found.

THE HOT-ACTIFICATION SULPHUR RECOVERY PROCESS

When the recovery of hydrogen sulphide for the manufacture of sulphuric acid is desired, a modification of the Seaboard process, broadened into a new process known as the hot-actification sulphur recovery process, may be used. In this process, steam is used as the desorbing or actifying gas in the contact tower in place of the air used for the same purpose in the Seaboard process.

A simple application of the process would employ a Seaboard process plant in which the air was replaced by steam at atmospheric pressure. The steam required would be about 37 pounds to replace each 1000 cubic feet of actifier air; or, for a gas containing 500 grains of hydrogen sulphide per 100 cubic feet, about 96 pounds of steam per 1000 cubic feet of gas purified, where 90 per cent removal of the hydrogen sulphide from the unpurified gas is contemplated.

Since this expenditure for steam alone represents a high cost for sulphur removal, the desorption contact-column is actually operated under a vacuum maintained by a conventional, reciprocating vacuum pump. By this means, the absolute pressure in the actifier tower may be reduced to 4 inches of mercury, lowering the steam required to provide 1000 cubic feet of vapor, to 6 pounds. The actual steam necessary for the cited hypothetical case now becomes only 15 pounds per 1000 cubic feet of gas purified and the cost of the operation becomes attractive.

The sweep steam pressure drop through the solution-actifying column has a marked influence on the steam efficiency of the desorption step. Thus, if a bubble-cap tower were used, the effective vacuum and consequent volume of sweep steam per pound would be much lower than with a packed tower. Significant differences are also found between various types of tower packing. The one having the lowest resistance is a steel-spiral packing made by twisting a stainless steel strip, approximately one-hundredth of an inch thick and three-eighths of an inch wide, into spirals an inch in diameter with a one-inch pitch. These spirals are cut into one-foot lengths and packed in the tower, on subway grating supports, in layers about 10 feet thick. With a conventional vacuum pump at the outlet of a tower packed with this steel-spiral packing, an absolute pressure of 4 inches of mercury may be practically maintained at the base of the column in regular operation. This insures the maximum possible steam efficiency for desorption.

Since the temperature of steam at these low pressures is only about 55 C, the necessary heat may be supplied in a by-product coke-oven plant by heat exchange from the raw coke-oven gas between the collecting main and the primary cooler. This will reduce the gas-cooling load on the primary cooler.

A reboiler coil is provided in the base of the actifier tower to act as a spare on the heat-exchange equipment and to make up any heat deficiency during start-up or abnormal operation.

By these niceties of design, the heat necessary for the process may be obtained in a normal by-product coke-oven plant without consumption of additional fuel.

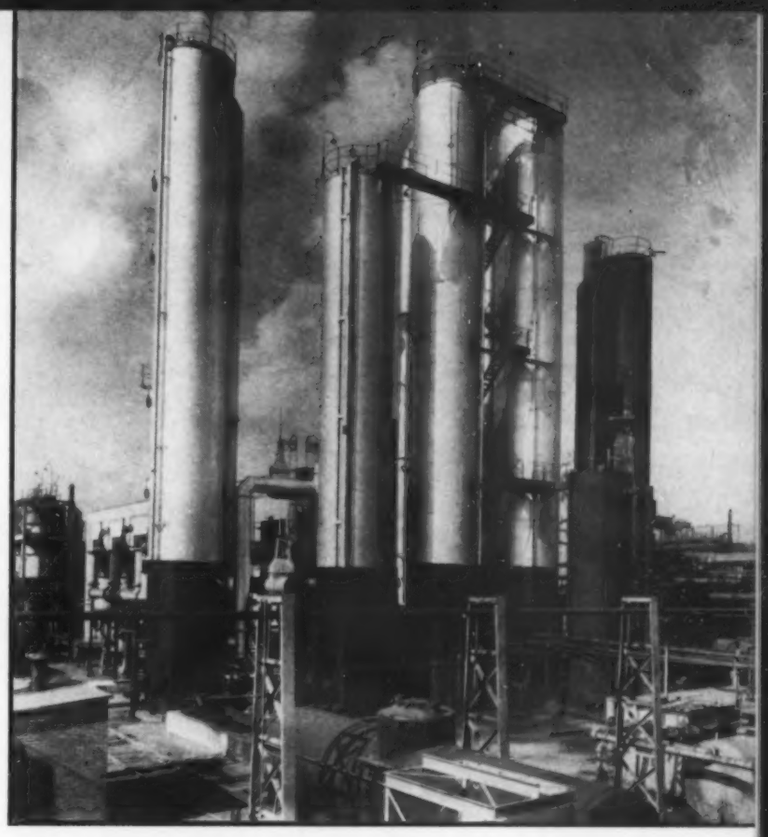


Figure 3 — Absorber, final cooler, and benzol washers of hot-actification sulphur recovery plant.

The flow sheet, Figure 1, shows the arrangement of the equipment used for this process. With the exception of the vacuum pump for maintaining the low pressure in the actifier and delivering the hydrogen sulphide to the acid plant, the condenser for the steam vapor and the cooler for the actified solution, the equipment is much the same as that used for the Seaboard process.

With this equipment these limitations of the Seaboard process are overcome:

(a) The sulphur is recovered as hydrogen sulphide available for the manufacture of sulphuric acid in a contact or lead-chamber plant.

(b) The side reactions are eliminated. On account of the lack of oxygen in the actifier, the hydrocyanic acid passes through without reaction and is recovered with the hydrogen sulphide. Also, on account of the lack of oxygen, the oxidation reaction to thiosulphate is absent.

(c) Since the hydrogen sulphide is recovered for use, no disposal need be provided.

Carbon dioxide is absorbed from the gas in both the Seaboard and hot-actification processes. Likewise, the absorbed carbon dioxide, in both cases, is desorbed in the actifiers so that the amount absorbed is equivalent to the amount desorbed. In the hot-actification process, however, due to the higher operating temperature of the actifier, the carbon dioxide-desorption rate is higher than that in the Seaboard process. Consequently, in the hot-actification process, the bicarbonate concentration will not increase to as high a point as it will in the Seaboard process. On account of this lower operating bicarbonate concentration, the hydrogen sulphide carrying capacity of the solution is greater and the hot-actification process may be operated at a much lower

solution circulating rate. The attendant savings in pumping costs and steam consumption are important.

THE PITTSBURGH COKE & CHEMICAL COMPANY PLANT

In this plant, shown in Figure 2, the coke-oven gas from the outlet of the ammonium-sulphate saturators passes first through direct final coolers.

In order to insure that none of the hydrogen cyanide is absorbed in the final cooler, the circulating water is indirectly cooled in cooling coils and not in an atmospheric cooling-tower. The hydrogen cyanide concentration of the circulating water attains an equilibrium with the concentration in the gas, allowing the total hydrogen cyanide to pass on through the final cooler for later absorption in the sodium-carbonate hydrogen sulphide absorbing solution, desorption, and recovery.

The next apparatus through which the gas flows are the benzol washers. In these washers the light oil is removed from the gas by direct counter-current scrubbing with straw-oil, which circulates through the washers and the wash-oil still. The straw-oil wash also removes the naphthalene from the gas, eliminating all trouble from concentrations of naphthalene in the sulphur-recovery plant.

Next in the line of flow of the coke-oven gas, now substantially free of tar and naphthalene, is the absorber of the sulphur-recovery plant. In this direct-contact packed tower the gas is scrubbed counter-currently with a dilute solution of sodium carbonate at about 25 C.

Figure 3 shows the final cooler, benzol washers and the absorber of the hot-actification sulphur-recovery plant.

Figure 1 shows the arrangement of the equipment for the hot-actification sulphur-recovery unit.

This solution absorbs about 90 per cent of the hydrogen sulphide and an almost equal proportion of the hydrogen cyanide from the gas together with a part of the carbon dioxide.

From the absorber, the solution is circulated through the vacuum actifier by means of which the hydrogen sulphide, hydrogen cyanide, and part of the carbon dioxide are desorbed from the solution. The actified solution, after cooling, is recirculated over the absorber tower to remove more of the acidic gases from the coke-oven gas.

The mixed gases at the outlet of the actifier column, consisting of hydrogen sulphide, carbon dioxide, and hydrogen cyanide, are cooled in an indirect cooler and then pass through the vacuum pump which serves to expand the volume of vapors in the actifier tower as previously described.

The mixed compressed gases leaving the vacuum pump are further cooled in a second indirect cooler to remove the heat of compression and still further to remove the condensate down to a temperature of about 35 C, and they are then scrubbed with cold water at about 18 C and 5 pounds pressure in a packed tower. More than 99 per cent of the hydrogen cyanide is absorbed.

Figure 4 shows the arrangement of the equipment for the manufacture of sodium cyanide. The scrubbing water, containing practically all of the hydrogen cyanide, and small concentrations of hydrogen sulphide and carbon dioxide, is preheated in an indirect-steam heater to about 97 C and pumped to a fractionating tower in which the hydrogen sulphide and carbon dioxide are distilled from the water. The hydrogen cyanide remaining in the water is withdrawn from the tower in a side stream. The bottoms, consisting of water, free of hydrogen cyanide, are run to the sewer from the bottom of the tower. This water amounts to about 600 gallons per hour for a plant carbonizing 2000 net tons of coal per day.

The water removed from this tower as a side stream is quantitatively free of hydrogen sulphide and carbon dioxide. It is run into 500 gallon receivers and treated

Figure 4 — Flow sheet of sodium cyanide unit used for HCN purification and recovery.

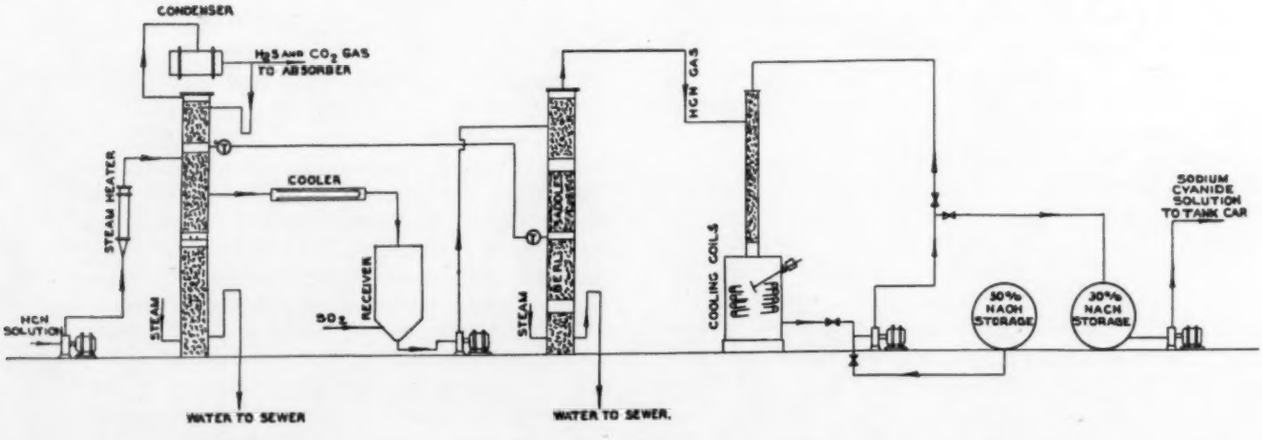


TABLE I

HYDROGEN CYANIDE CHARGED TO THE STILL

Day	Rate, gal per hour	Per cent HCN	Hours	Gal	Lb of solution	Lb HCN
1	76	4.5	15	1,140	9,382	422
2	76	5.4	5	380	3,127	169
3	93	4.7	15	1,395	11,481	540
4	130	5.1	24	3,120	25,677	1,310

Gross total hydrogen cyanide charged — lb	2,441
Less hydrogen cyanide in 1 receiver — lb	249.7
Total net charge — lb	2,191.3
Equivalent NaCN — lb	3,974.5

as a batch with a very small amount of sulphur dioxide from the sulphuric acid plant to prevent polymerization of the hydrogen cyanide to azulmic acid. The concentration of hydrogen cyanide in the water from the first tower is about 4 per cent.

The water is pumped from the receivers to a second tower where it is distilled with open steam. The hydrogen cyanide gas and some water vapors come off overhead and the water bottoms are run to the sewer.

Next, the hydrogen cyanide is passed through a packed absorption tower over which is circulated a batch of 50 per cent sodium hydroxide solution. As the solution is circulated, the alkalinity gradually decreases and the percentage of sodium cyanide gradually builds up. The batch is considered finished when the sodium hydroxide concentration has been reduced to abcut 1 per cent. About twenty times as much caustic is continuously circulated over the absorption tower as necessary to convert the available hydrogen cyanide to sodium cyanide. This makes a clear water-white product. The hydrogen cyanide towers are shown at the left of the picture in Figure 5.

The efficiency of the distillation and conversion of the recovered hydrogen cyanide may be shown by the test data on the hydrogen cyanide still in Table I.

Sodium cyanide produced

Total solution produced — gal 1,657.0
Analysis: NaCN . . . . . 22.33 per cent
Sp gr 1.198
8.328 lb per gal × 1.198 sp gr × 1,657 gal
× 0.2233 NaCN = lb NaCN 3,691.5
Plus material in receiver — gal 454
Analysis: NaCN . . . . . 4.17 per cent
Sp gr 1.2
8.328 lb per gal × 1.2 sp gr × 454 gal
× 0.0417 NaCN = lb NaCN 189.2

Total NaCN made — lb 3,880.7

Per cent recovery

$$\frac{3,880.7}{3,974.5} \times 100 = 97.6 \text{ per cent}$$

All the apparatus is small sized and may be made of ordinary materials. The towers are of steel pipe packed with clay Berl saddles. Tanks and receivers are of steel plate, and condensers, coolers, and piping are of steel. All pumps are of cast iron. The apparatus is all out-of-doors except for a small room for the instruments and control laboratory.

Using common materials for the simple and relatively small-sized apparatus, the recovery of hydrogen cyanide and production of sodium cyanide offer an attractive return. The scrubbed gas, consisting of hydrogen sulphide and carbon dioxide, is piped to the sulphur furnaces of the acid plant for the production of sulphuric acid. Typical operating results for the hot-actification sulphur recovery plant are shown in Table II.

LATER DESIGNS

A new plant is now being built at another location in which advantage is being taken of the lessons learned in the operation of the present unit.

In a specimen plant of the new type, where the heat for actification of the solution will be obtained by heat exchange, the operating results and efficiencies will be about as shown in Table III.

Figure 5 — At the left of the picture are shown the hydrogen cyanide towers of the sodium cyanide unit.

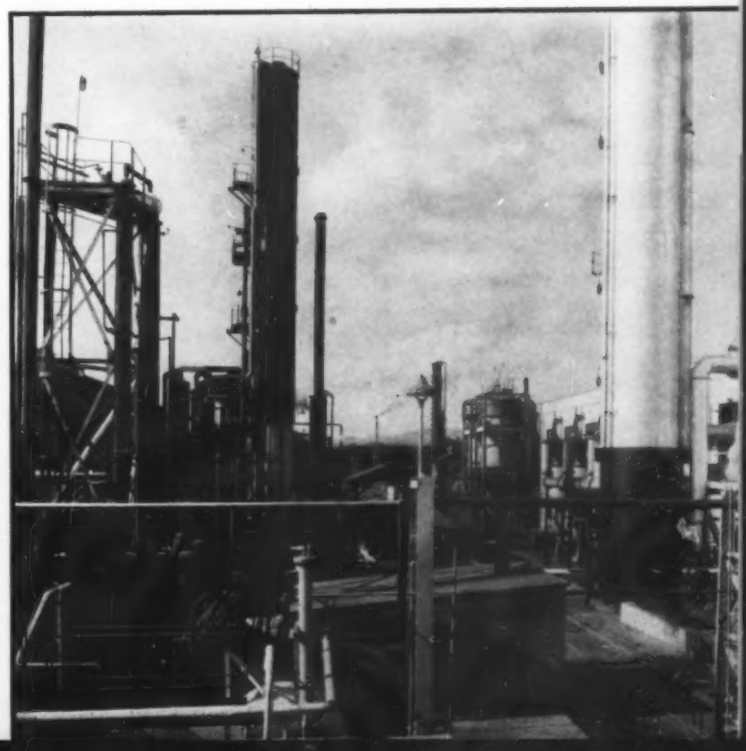


TABLE II

PITTSBURGH COKE & CHEMICAL COMPANY HYDROGEN SULPHIDE RECOVERY PLANT

Day	Per cent sulphur in coal mix	Cu ft gas treated per day	Grains hydrogen sulphide per 100 cu ft of gas		Per cent hydrogen sulphide removed	Tons of hydrogen sulphide per day	Tons of sulphur per day
			Inlet	Outlet			
1	1.15	20,036,000	456	51	88.2	5.786	5.452
2	1.26	20,033,000	470	47	90.0	6.052	5.694
3	1.19	19,750,000	433	45	89.6	5.473	5.148
4	1.22	19,659,000	448	44	90.2	5.673	5.337
5	1.27	19,696,000	438	43	90.2	5.557	5.228
6	1.17	19,757,000	450	45	90.0	5.715	5.376
7	1.10	19,861,000	480	48	90.0	6.128	5.765
8	1.28	19,638,000	451	46	89.8	5.680	5.343
9	1.32	19,962,000	454	48	89.2	5.788	5.445
10	1.29	20,055,000	442	46	89.6	5.672	5.336
11	1.14	19,936,000	460	45	90.2	5.909	5.559
12	1.27	20,053,000	498	56	88.5	6.273	5.901
13	1.15	19,805,000	467	47	89.9	5.941	5.589
14	1.08	19,751,000	488	51	89.5	6.165	5.800
15	1.14	19,775,000	484	51	89.5	6.116	5.753
16	1.32	19,805,000	484	49	89.8	6.153	5.788
17	1.25	20,347,000	467	46	90.1	6.118	5.755
18	1.10	20,056,000	452	43	90.2	5.859	5.512
19	1.24	19,911,000	464	53	90.4	5.845	5.498
20	1.18	19,875,000	463	47	89.9	5.905	5.555
21	1.36	19,916,000	457	45	90.1	5.860	5.513
22	1.24	19,719,000	458	45	90.3	5.817	5.472
23	1.35	19,819,000	455	45	90.0	5.804	5.460
24	1.23	19,906,000	450	45	90.0	5.758	5.417
25	1.24	19,721,000	444	59	86.7	5.423	5.101
26	1.24	19,910,000	434	45	89.6	5.532	5.204
27	1.10	20,734,000	435	45	89.9	5.775	5.433
28	1.11	19,861,000	441	45	89.8	5.617	5.284
29	1.12	20,096,000	457	43	90.6	5.942	5.590
30	1.19	19,687,000	432	42	90.2	5.484	5.159
Average	1.21	19,904,000	457	47	89.7	5.829	5.4822

TABLE III

OPERATING DATA FOR A SPECIMEN PROJECT

Gas treated per day — cu ft 24,000,000
Inlet gas pressure — inches of water 20
Average inlet H_2S — grains per 100 cu ft ... 500
Average outlet H_2S — grains per 100 cu ft .. 50
Average H_2S removed — lb per day 15,400
Sulphur available — lb per day 14,500
Efficiency of H_2S removal — per cent 90
Sulphur recovered — net tons per day 7.25

Utility and chemical requirements:

Live steam

Equivalent steam required for process — actually supplied by heat exchange — lb per hr ... 13,000

Service water

Solution cooler — gal per hr 24,000
Vapor condenser 30,000
Total gal per hr 54,000

City water

Vapor cooler — gal per hr 2,000

Electric power

Vacuum pump — kwhr per hr 110
Actified solution pump 20
Foul solution pump 9
Flash solution pump 21
Condensate pump 1
Fresh solution pump 1
Circulating water pump 2
Lighting — average 1
Total kwhr per hr 165

Sodium carbonate

$\frac{40 \times 24{,}000{,}000}{7{,}000 \times 1{,}000}$ = lb per day 140

Operating cost purification unit — per day

Service water — 54,000 × 24 × 1¢ $13.00
City water — 2,000 × 24 × 5¢ 4.80
Electricity — 165 × 24 × 0.5¢ 19.80
Sodium carbonate — 140 lb × 2¢ 2.80
Labor — 24 × $1.00 ..... 24.00
Maintenance 25.00
Total $89.40
Cost per M cu ft gas purified ..... 3.7 mills
Cost per net ton sulphur recovered $12.30

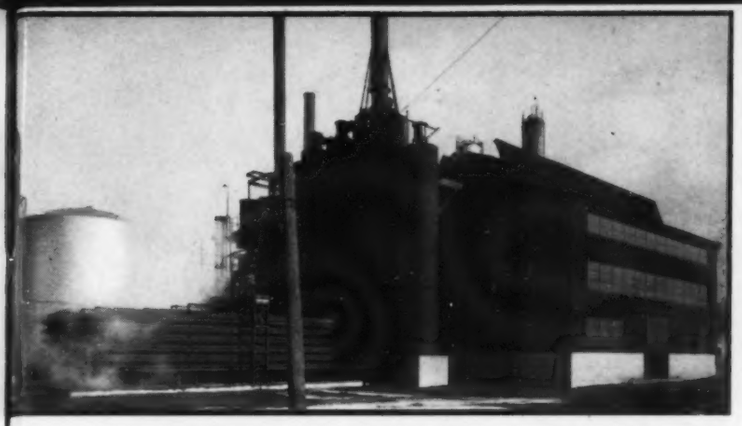


Figure 6 — External view of contact acid plant.

The contact-acid plant of the Pittsburgh Coke & Chemical Company comprises three standard 30-ton units. One unit is specially arranged for burning by-product hydrogen sulphide together with any necessary molten brimstone. On this unit, equipment is provided for conditioning the resultant sulphur dioxide bearing gases for conversion to sulphur trioxide in contact with the standard vanadium-mass catalyst.

Figure 6 is an outside view of the contact-acid plant, showing acid-cooling coils, the acid absorbers, and the building housing the furnaces, blowers, converters and control apparatus.

Figure 7 shows arrangement of the equipment for the manufacture of sulphuric acid from the hydrogen sulphide recovered from the coke-oven gas. In the acid plant, the hydrogen sulphide, freed of hydrogen cyanide but still containing some carbon dioxide, is burned directly in the sulphur furnace of the contact-process sulphuric acid plant.

Here the following reaction takes place:

$$2\,H_2S + 3\,O_2 \rightarrow 2\,SO_2 + 2\,H_2O \qquad (10.)$$

Hydrogen sulphide — Oxygen — Sulphur dioxide — Water

In this plant the hydrogen sulphide and sulphur burning furnace is a cylindrical furnace in which atomized sulphur and hydrogen sulphide gas are burned. Figure 8 shows an external view of the furnaces.

The hydrogen sulphide delivered to the furnace passes through one of a pair of flame arresters before going to the burners. By means of by-pass valves, the other can be removed for cleaning, without disturbing the operation.

In case of power failure, a solenoid valve closes the hydrogen sulphide line. A similar valve is provided on the line from the sulphur pump to the sulphur burner.

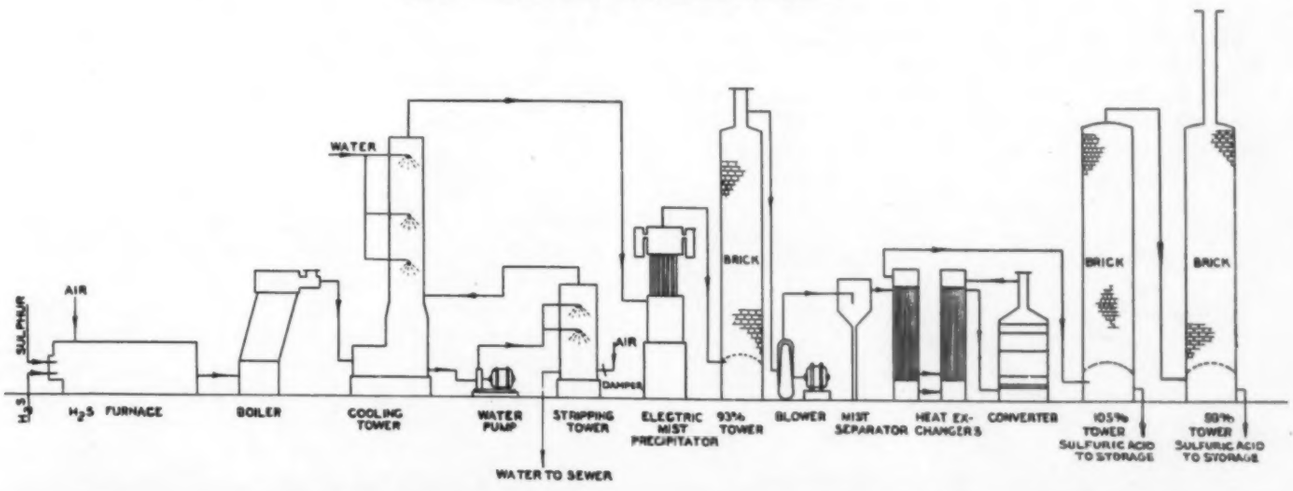
If the hydrogen sulphide feed to the furnace is cut off, the hydrogen sulphide is released through a relief valve and discharged into a fuel-gas line. This relief valve is set at 3 pounds gauge pressure. The flow rate of the hydrogen sulphide is shown by an indicating flow meter.

It is important that sufficient air always enters the furnace to obtain complete combustion of the hydrogen sulphide and the sulphur. An indicating and recording pyrometer is connected to the gas outlet end of the furnace to show the combustion temperature by which it is possible to adjust the quantity of air, with reasonable certainty, supplied to the furnace. It is also important to maintain enough oxygen in the gases leaving the furnace to prevent sublimation of sulphur in the cooling tower. The temperature at the gas outlet of the furnace should not exceed 1200 C to produce a gas containing approximately 10 per cent sulphur dioxide when burning both sulphur and hydrogen sulphide.

There are two main differences between burning sulphur and burning hydrogen sulphide in a contact sulphuric acid plant. In the first place, more heat is evolved from the added combustion of the hydrogen in the hydrogen sulphide than from the sulphur alone. In the second place, the hydrogen burns to water which goes on through the system with the sulphur dioxide.

This added heat, in the form of high temperature of the gas, and the water vapor, would have deleterious effects on the catalyst mass in the contact sulphuric acid plant if allowed to enter the converters. Therefore the sulphur dioxide must be cooled, and treated to remove the water. This is accomplished in several stages. First, the gases at about 770 C are passed through a waste-heat boiler to recover much of the useful heat as steam. This boiler is of an inclined, vertical fire-tube type with a separate steam drum designed for a high water circulation rate. It is equipped with a feed-water regulator, for maintenance of a constant water level.

Figure 7 — Flow sheet of contact acid plant.



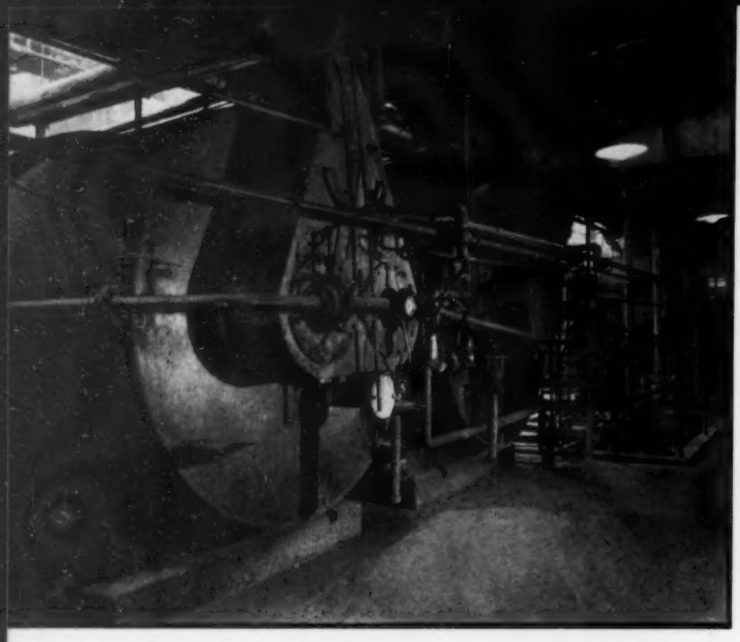


Figure 8 — Hydrogen sulphide and sulphur are burned in cylindrical furnaces.

The boiler design is further based on an inlet temperature of 1100 to 1200 C and an outlet temperature of 425 to 475 C during normal operation. The high outlet temperature of the boiler is necessary to protect it from corrosion by the water-bearing gases formed by the combustion of hydrogen sulphide. The temperature at outlet of the boiler is measured by a recording potentiometer and also an indicating instrument.

Second, the gases are scrubbed in a direct contact tower with recirculated, cooled water to condense as much water vapor as practical. This circulating water carries off some sulphur dioxide and is quite noxious. An air-stripping tower is therefore included in the water circulating system to remove and recover the absorbed sulphur dioxide which is returned to the sulphur dioxide stream at the inlet to the water washing, direct cooling tower. The sulphur dioxide-free water is run to the sewer.

The cooling tower always contains a bath of liquor at the bottom so that the incoming gases can be shock-cooled by direct contact. Fresh water, reasonably free from chlorine or salts, is supplied to the sprays on the tower, further cooling the gases. The liquor from the cooling tower overflows to a discharge box from which a centrifugal pump forces it to the stripping tower. By means of a damper, a small amount of air is admitted into the stripping tower to remove the sulphur dioxide from the liquor. This air is discharged into the main gas stream entering the cooling tower. The amount of water supplied to the sprays on the cooling tower is regulated to provide the maximum temperature of the liquor leaving the tower which is approximately 65 C. The temperature of the gas leaving the cooling tower is kept as low as possible, varying, depending upon the gas composition, from 32 to 43 C.

Third, the gas is passed through an electric precipitator to remove all possible mechanical traces of water. Finally, it is scrubbed with concentrated 93 per cent sulphuric acid in a direct, brick-packed scrubber. The dried gases are aspirated by means of a centrifugal blower and pumped through a special mist-separator to reduce the sulphuric mist to a minimum. They are then preheated in a heat exchanger to about 300 C at which temperature they enter the catalyst mass in the converter shown in Figure 9.

Here the reaction

$$\underset{\text{Sulphur dioxide}}{2\,SO_2} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Sulphur trioxide}}{2\,SO_3} \qquad (11.)$$

takes place due to contact of the proper proportions of sulphur dioxide and oxygen with the catalyst at the correct and closely controlled temperature.

The catalyst is a vanadium pentoxide mass supported on an inert carrier, such as diatomaceous earth, which is not combustible under the operating conditions and the temperature of 450 C necessary to perform the conversion. It is essential that this temperature be closely controlled in order that the conversion be maintained at the maximum practical point, 97 per cent. Variations below 450 C allow increasing percentages of sulphur dioxide to escape conversion while higher temperatures cause the reaction to reverse to

$$\underset{\text{Sulphur trioxide}}{2\,SO_3} \longrightarrow \underset{\text{Sulphur dioxide}}{2\,SO_2} + \underset{\text{Oxygen}}{O_2} \qquad (12.)$$

The result of high or low temperatures is plainly a lower percentage conversion.

Figure 10 shows the modern instrumentation and control equipment for the contact acid plant.

In this plant, where insufficient hydrogen sulphide is available for the manufacture of the required quantity of sulphuric acid, the hydrogen sulphide is burned in the same standard sulphur furnace with the necessary molten sulphur supplied under pressure by a steam turbine-driven submerged centrifugal pump to the spray type sulphur burner. The dried air for the combustion enters the furnace at about 40 C.

After leaving the converter the sulphur trioxide just produced is cooled by heat transfer to the incoming sulphur dioxide bearing gases in the heat exchanger previously mentioned, and it thereafter enters the absorption tower which is packed with ceramic spiral-ring packing. There it is scrubbed with hot 98 per cent sulphuric acid which is circulated over the tower. Water is added in quantity sufficient to produce 98 to 99 per cent acid.

The heat generated by drying the moist sulphur dioxide-bearing gases, and the heat of absorption of the sulphur trioxide in the absorption tower, is removed by passing the circulating acid through an acid-cooling system.

To maintain the acid strength for the drying tower circulating system provisions are made for the addition of some of the 98 per cent acid to the 93 per cent drying tower circulating system, from which the diluted acid is returned to the absorption tower for further fortification.

When operating only on hydrogen sulphide no labor is required except in control of the process. If additional sulphur is required it must be added to the sulphur melting tank. Temperatures are simply controlled by the heat-exchange apparatus. Actual strength of the different acid concentrations made is controlled by the recirculation through the towers.

The total efficiency of removal and recovery which

may be obtained from a plant designed with our present experience will be 95 per cent hydrogen sulphide removal from the gas multiplied by 96 per cent conversion to sulphuric acid, giving an over-all conversion efficiency of 91 per cent from sulphur in the gas as hydrogen sulphide to sulphur in the finished concentrated sulphuric acid.

Application of hydrogen sulphide for manufacture of sulphuric acid by the lead chamber process should be practical. With this combination it would be necessary to remove some of the heat from the products of combustion and to wash the gas for removal of excess water before passing it to the nitre furnace.

THE COST OF MANUFACTURING SULPHURIC ACID

The main factors that make up the cost of manufacturing of sulphuric acid are the cost of sulphur, labor, steam, and power. Conditions will vary in each plant and the figures given here are costs from the Pittsburgh Coke & Chemical Company plant, in terms of utilities and materials used.

The total connected electric load in the acid plant is 183 horsepower. The total connected load for the hydrogen sulphide plant is 85 horsepower. In addition, there is a deep-well pump with an 85 horsepower motor which furnishes water for both plants.

For a specimen month during which 2093 net tons of 66 degree Be acid were made, the data are as follows:

Sulphur as hydrogen sulphide — gross ton	142
Sulphur — gross ton	475
Soda ash — lb	4,000
Power — kwhr	151,240
Steam — M lb	10,800
Service water — M gal	
Operating labor — hr	2,746
Repair labor — hr	420
Supplies	$ 20.00
Repair material	$450.00
Laboratory expense	$150.00

In addition, expenses were incurred for taxes, insurance, tank-car rental, shipping expense, and general works overhead.

During the specimen month the plant produced 2093 tons of 66 degree Bé acid. Of this amount 472 tons were made from hydrogen sulphide. The by-product coke plant used 495 tons of sulphuric acid in the production of ammonium sulphate. In other words, the plant produced from hydrogen sulphide 95.7 per cent of the sulphuric acid required for the manufacture of ammonium sulphate.

In this summary there is no credit given for the cleaning of the coke oven gas. In any situation, if the sulphur recovery plant replaces existing gas purification, purification cost should show as a credit against the cost of acid. If the purified coke oven gas is of more value to the steel mill, then the additional value given to the gas should be credited to the acid plant.

In most cases, with a hydrogen sulphide concentration of 450 grains per 100 cubic feet in the raw gas, and with power and water at usual steel plant costs, the manufacture of sulphuric acid will be a profitable undertaking. Both the sulphur recovery and the contact-acid plants can be successfully operated with no more than normal difficulty for the usual by-product plant equipment. The writers believe that the manufacture of sulphuric acid is a proper development for the by-product coke industry.

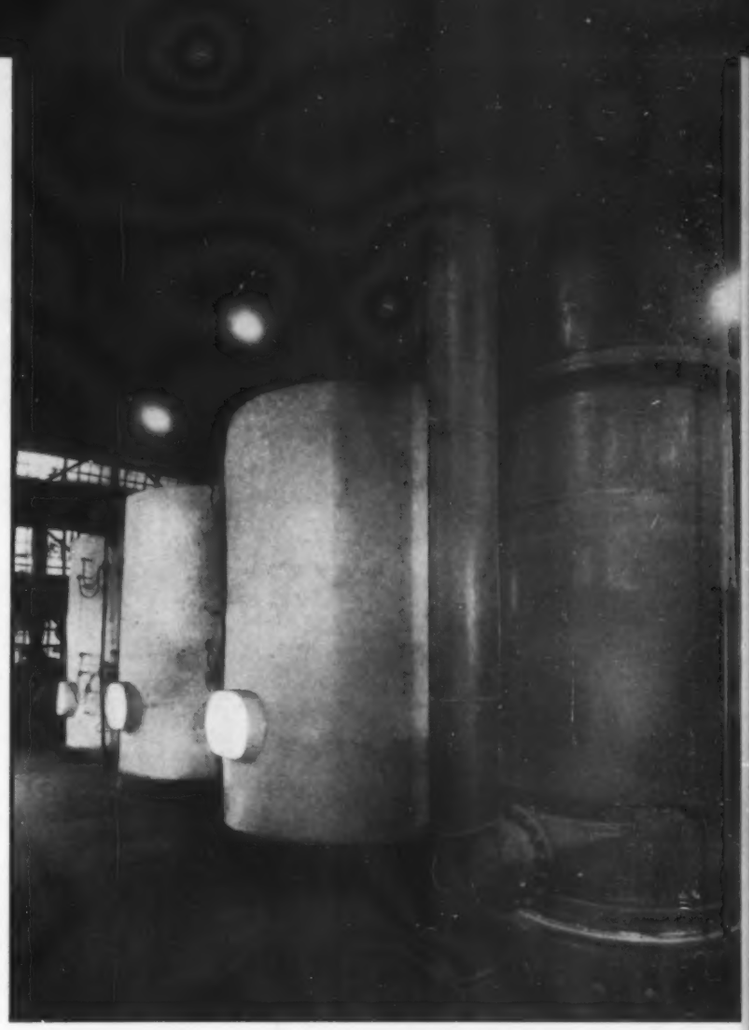


Figure 9 — The SO_2 picks up the necessary O_2 to form SO_3 in the converters shown. The SO_3 cooler is in the foreground.

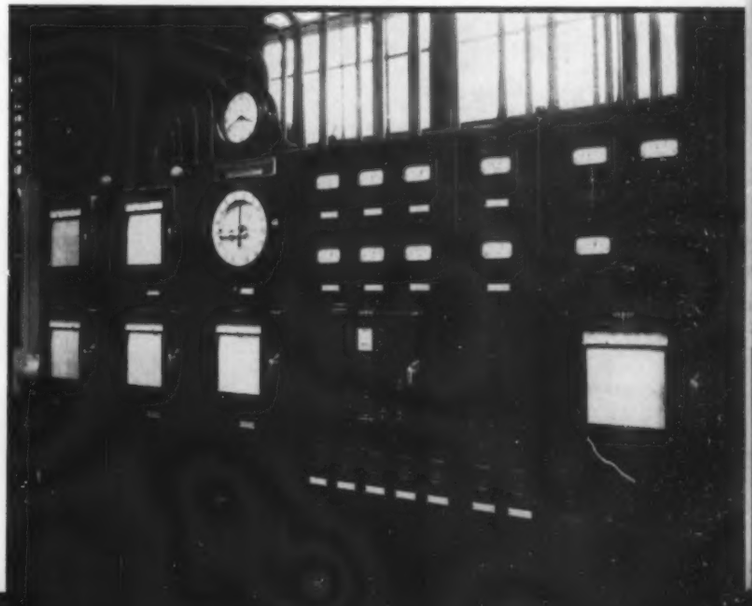


Figure 10 — Modern instrumentation and control panel for contact acid plants.

DISCUSSION

PRESENTED BY

F. D. SCHREIBER, General Superintendent, Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania

F. D. Schreiber: While Mr. Leech read this paper, I began to think it was highly technical. I am not going to say anything about the technical aspects of our plant; we like it very much. We have put in an additional unit, and we are now making 3000 tons of sulphuric acid a month.

On the sulphuric acid plant, we think we make about 33 per cent on our investment; on the cyanide plant we make about 100 per cent on our investment. The latter is a small plant, but it turns out a high-priced material. Sulphur may be about $17.00 a ton, while hydrocyanic acid may be 10 cents a pound.

I think one ought to look into making one's own sulphuric acid but I do not know just how it would work out in the Birmingham district. We bring quite a lot of raw material in by barge at a low freight rate. You ought to be able to get in by water any additional sulphur required inexpensively.

In the Pittsburgh district, all coal will be cleaned in the near future. This gives a very nice reduction in ash, which is good. It happens that the sulphur does not come down proportionately. If there is a reduction of ten or fifteen points in the sulphur it is about all that may be expected from any kind of cleaning plant on our coals.

The ammonia in the gas must be taken out. How much it costs to make ammonia in a coke plant is anybody's guess. We have to go through all kinds of maneuvers to remove it from the gas.

A ton of ammonium sulphate at $29.00 contains three-quarters of a ton of sulphuric acid If you could make that sulphuric acid at a low cost, certainly that three-fourths of a ton of $29.00 a ton ammonium sulphate can be made at a nice profit. How much the ammonia costs is anybody's guess.

I have been worrying about ammonium sulphate prices, for we will probably have a lot of government competition in fertilizers.

In the South, interest is in cheap fertilizers and in cheap cotton. Cotton is now subsidized and will probably continue to be subsidized to some extent, but it is up against a pretty tough proposition from all of the synthetic fabrics which are coming out and which I personally think will be better than cotton. I think the only way cotton can compete is to be low in price. The only way you can get cheap cotton is to use fertilizer and a lot of mechanical equipment. Certainly you will have to get the price of sulphate down to where it will compete with other fertilizers. It cannot be kept up artificially and the price of cotton cannot be kept up artificially. We think this process is a good thing in our plant and we make a very good revenue on it, and it is a proposition that fits in with the whole scheme of our operations.

GRID Unit Heaters are free from electrolysis because they are *one* type metal — cast iron — the same metal as the steam supply and return pipes, and the boiler itself. They cannot be influenced by electrolytic action, as there are no dissimilar metals anywhere. There is no other unit heater like GRID. They will last as long as the pipes furnishing steam to them. The heating sections are one piece cast construction (patented) of high test cast iron that will withstand steam pressures up to 250 lbs. In these heating sections there are no soldered, brazed, welded, or expanded connections to become loose or develop leaks. Capacity tables and complete information upon request.

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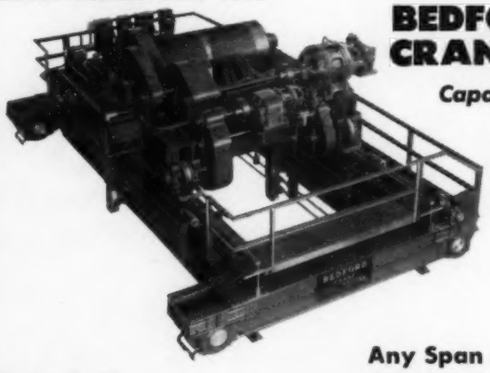

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A Discussion of

LEATHER PACKINGS FOR HYDRAULIC ROLL JACKS

. . . . the following is a written discussion of a paper by R. F. Justice, which was published in the September 1946, Iron and Steel Engineer . . . .

by Edward Plumley

JOHN LYSAGHT, LTD.

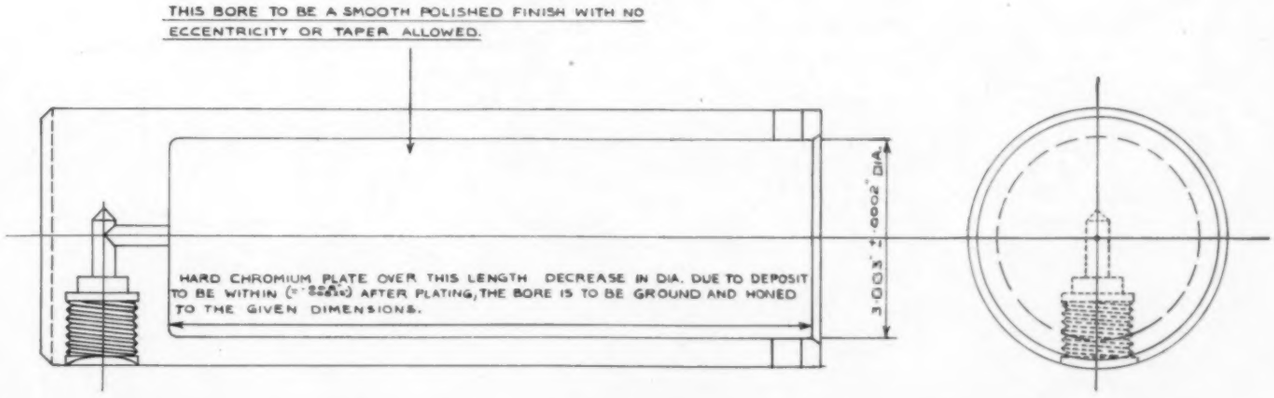
ORB IRON WORKS

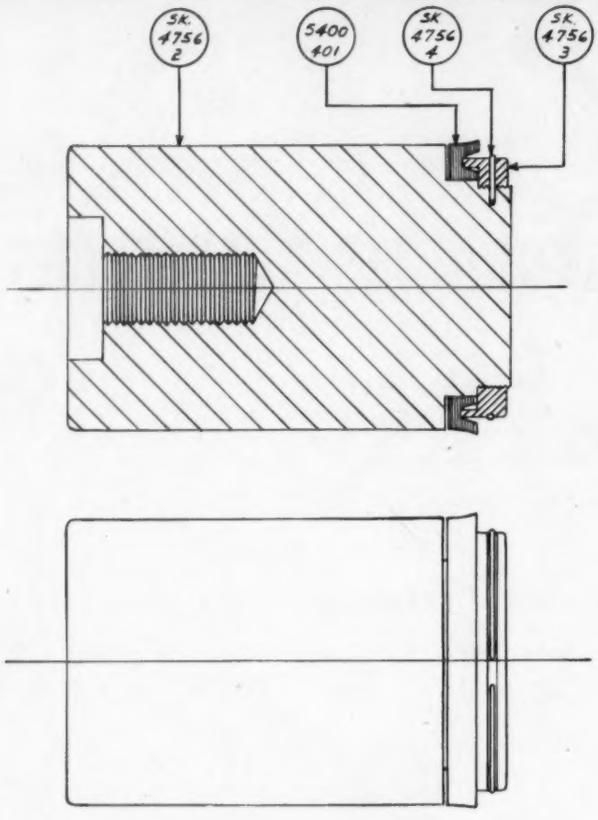
NEWPORT, ENGLAND

▲ THE paper given by Mr. R. W. Justice of E. F. Houghton Company, Youngstown, Ohio in the September issue of the Iron and Steel Engineer refers to the maintenance of hydraulic jacks and leathers in 4-high cold reduction mills, in which the jacks are used to support the work rolls and back-up rolls.

We have at these works a mill consisting of 3 stands 20 in., and 49 in. × 80 in. made by the United Engineering Company of Pittsburgh, the mill being manufactured in England to their designs. This mill is arranged for the cold reduction of coils in the orthodox way, but has not yet operated in that way. The mill during the past ten years has been used for the reduction of moulds in a way similar to that adopted at the original Ashland Plant of the Armco Company. Our output on 20 gauge sheets, with an average width of just under 5 ft is approximately 800 to 900 tons per working week, the

Section through cylinder. The cylinders are bored to a tolerance of ± 0.0002 in.


THIS BORE TO BE A SMOOTH POLISHED FINISH WITH NO ECCENTRICITY OR TAPER ALLOWED.
HARD CHROMIUM PLATE OVER THIS LENGTH DECREASE IN DIA. DUE TO DEPOSIT TO BE WITHIN (= 32μ in) AFTER PLATING, THE BORE IS TO BE GROUND AND HONED TO THE GIVEN DIMENSIONS.
3.003" +.0002" DIA.



Piston assembly for hydraulic cylinder.

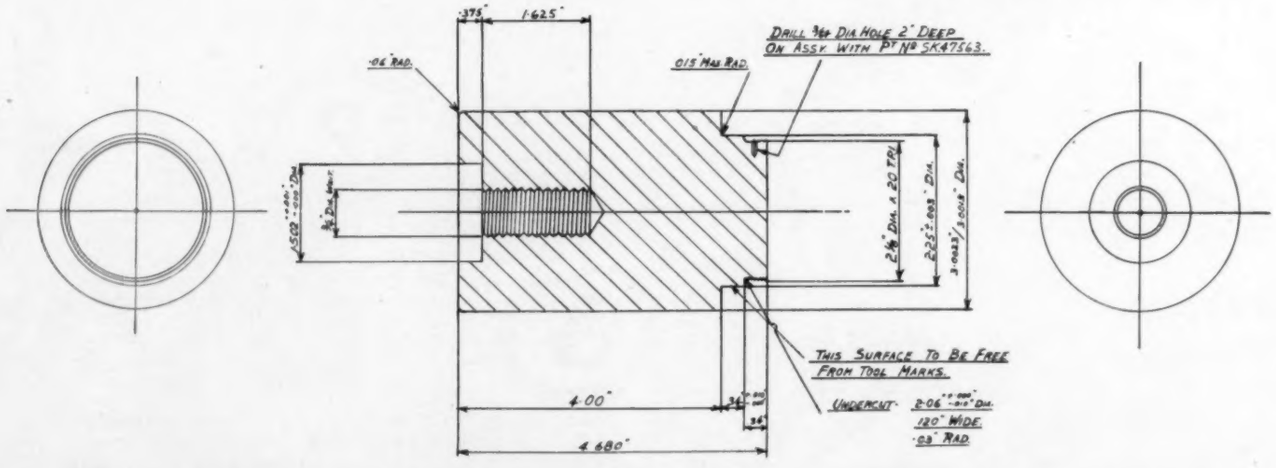
sheets being passed through the mills in tandem. In the majority of cases, it takes two runs through the mill, that is six passes, to reduce from mould gauge to finish gauge.

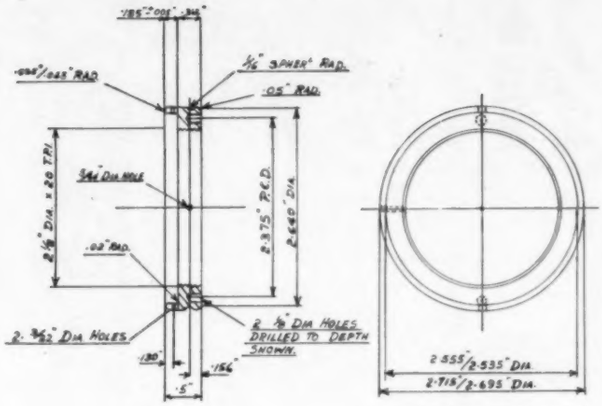
It is apparent then that the mills are really being operated as "jump" mills, because when sheets leave the rolls, the tension on the stand, which is equivalent to the rolling force, is relieved between every sheet. The speed of rolling is approximately half that of a continuous strip mill. Thus, there are two movements of the chocks, one up and one down, for every sheet passing through the mill, and the jacks supporting the rolls have much more work and consequently more attrition than is the case in strip reduction.

This leads to the question of maintenance of jack leathers, and we, in our particular case, had considerable trouble with the orthodox type of cup leather. Also, when the sheet leaves the mill, there is a considerable rise in pressure in the hydraulic jack system due to the rolling force between the rolls being relieved at the rear end of the sheet. In fact, the pressure gauge back at the hydraulic pumps shows a rise in pressure of approximately 2 to 2½ times the static pressure used in the hydraulic system. The intermittent and constant rubbing up and down of the jack leathers, together with the hammer blow type of rise of pressure in the hydraulic system both contributed to heavy maintenance of the leathers.

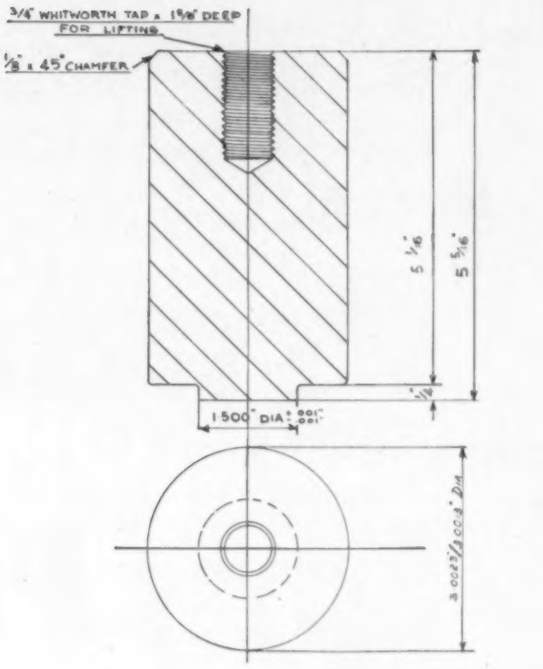
During the war, we had the experience of using bomber Oleo legs from the under-carriage of Handley Page bombers for pushing duralumin ingots through a 4-row, reheating furnace, the use of these being necessitated by urgency, as these were the only hydraulic jacks which were available to us. The piston rods of these cylinders and also the inside surfaces of the cylinders, were hard chromium plated and polished. The hydraulic medium in this particular case was ordinary good quality lubricating oil. The bucket of the piston (the cylinder being double acting) was fitted with synthetic rubber "U" leathers, and also the piston rod was packed with a similar design of seals. This furnace operated day and night for a period of approximately three years, each cylinder pushing at about 7 minute intervals, and not only was there a complete lack of maintenance during this period, but also there

Outside diameter of piston is limited to a range of 3.0023 to 3.0013 in.





The spacer is made of brass.

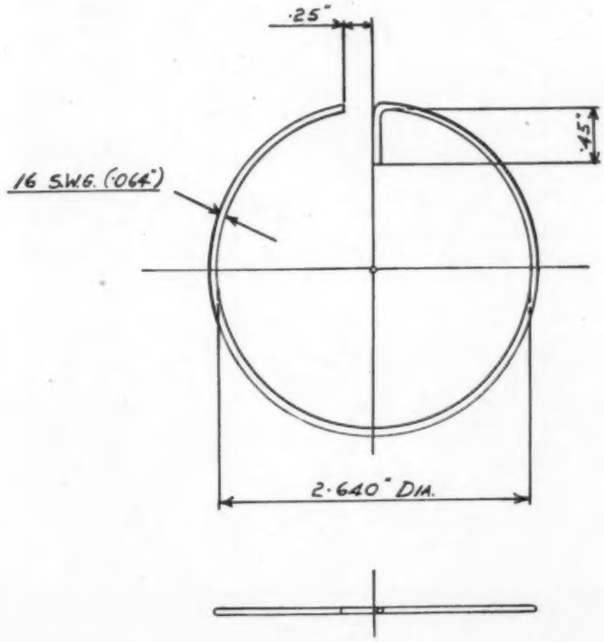


The details of the balance plunger are shown in this section.

was not one single drop of oil to be seen leaking anywhere.

It was the reliability of this equipment which prompted us to visualize that we could improve the reliability of our 4-high mill jacks, and although the cylinders were worn, we had them reground and then electroplated internally with hard chromium plating of sufficient thickness to allow for grinding and polishing the bores to the correct dimensions. We then adopted the standard design as used in aeroplane practice, with the result that we arrived at a design similar to that shown on Figures 1 to 6. This is precision work. The "U" leathers were made of synthetic rubber, and the first of these applications operated for a period of 6 months to 9 months without attention. The bores of the cylinders are not wearing and in approximately two years of use, there has only been purchased a matter of half a dozen new seal washers, all of which have not yet been used.

The wire locking ring is formed from spring steel.



Incidently, the thickness of the oil film between the various clearances on the morgoil bearings and parts connected therewith, namely, the neck of the rolls (parallel design), between the bush and the neck of the rolls, also between the bush and the anti-friction metal on the sleeve, and also between the sleeve and the morgoil bearing housing, were responsible for a taper on the leading edge of the sheet, which proved to be a very considerable handicap to the correct gauging of the sheet. The length of this taper portion of the sheet was directly proportional to the speed of the mill. It could more or less be eliminated by keeping the sheets almost butt and butt. With the object of keeping the oil film as thin as was practically possible, the fluid pressure of the jacks was raised to about 2½ tons per square inch (2240 lb), which further increased the arduous duty of the jack leathers. In spite of this drastic increase of pressure the new design of sealing washer continues to operate satisfactorily.

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"Steam is exhausted from the rooms where we empty our bone char by exhaust fans of two types—a 36 inch fan operated by ½ h. p. motor and a 24 inch fan operated by ¼ h. p. 3 phase—220 volt motor. The grilles or louvers open to the northeast right over the Delaware River. High winds will therefore sometimes stall the motors and in a very severe storm, the wind may even reverse the direction of the motor while it is running. Also, the starting current is increased greatly when the blades are revolving in the opposite direction, due to high wind.

"Prior to 1942, at least two of these fan motors were replaced every month, due to burnout. Replacement was very difficult and expensive due to the fact that the fans are mounted right below the ceiling and above steam pipes.

"Early in the summer of 1942 we installed 8 ampere Fusetrons for the ½ h. p. motors and 6¼ ampere Fusetrons for the ¼ h. p. motors. Up to August of 1945 we had not had to replace a single fan motor protected by Fusetrons."

David J. Coles, Electrical Engineer,
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"We have found Fusetrons and Fustats (Fusetrons with a tamper resisting base for 125v. circuits) so satisfactory for the protection of small motors that for a number of years we have refused to give a warranty with a rewound motor job unless the owner installed a Fusetron or Fustat to protect the motor. We saw to it that the size used would give burnout protection.

"We are convinced that this policy of installing a Fusetron or Fustat to protect all rewound motors has saved us a lot of unjustified complaints—and no one knows how much expense taking care of motors within the warranty period."

A. H. Wolf, Superintendent
of Motor Repair Dept.
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Burnout of motors from lack of oil, worn bearings, tight belt, overloading—or anything that causes a dangerous excess of current through the motor—can, on normal installations, be prevented by Fusetrons.

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If motor is on a separate circuit, install the Fusetron in the switch or panelboard. Then the motor as well as the circuit wiring is protected.

If the motor is on a general use circuit or a circuit feeding more than one motor, protect each motor individually by installing a switch or a fuse block with the proper size Fusetron. *It Is As Simple As That.*

Protect Against Cost of Replacing a Motor—and Against Production or Operating Losses

When pumps, fans, air compressors, blowers, conveyors, mixers, stokers, oil burners, grinders—or any of the hundreds of other circuits on which small motors are used—are out of service because of a motor burnout the losses incurred generally make the cost of Fusetron protection seem mighty small.

You not only have the cost and trouble of removing and replacing the destroyed motor—but all the time the motor is down, production or operating losses pile up.

It's guarding against these double losses that makes it pay you so well, to go to the little expense and trouble necessary to install Fusetrons for the protection of all small motors used throughout your plant or building.

FUSETRONS GIVE MANY OTHER KINDS OF PROTECTION HERETOFORE NOT AVAILABLE

Fusetrons do everything fuses do, as is confirmed by the Underwriters' Laboratories' Label, and in addition . . .

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The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriter's Laboratory approval for both motor-running and circuit protection as the most expensive devices made.

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Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in tamper-resisting type (Fustats) for 125 volt circuits.

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Even one lost, hard-to-replace motor, or one needless shutdown or destroyed panel may cost you far more than replacing every fuse with a FUSETRON.

Don't risk such losses—protect your production schedules by changing over your entire electrical system to FUSETRONS.

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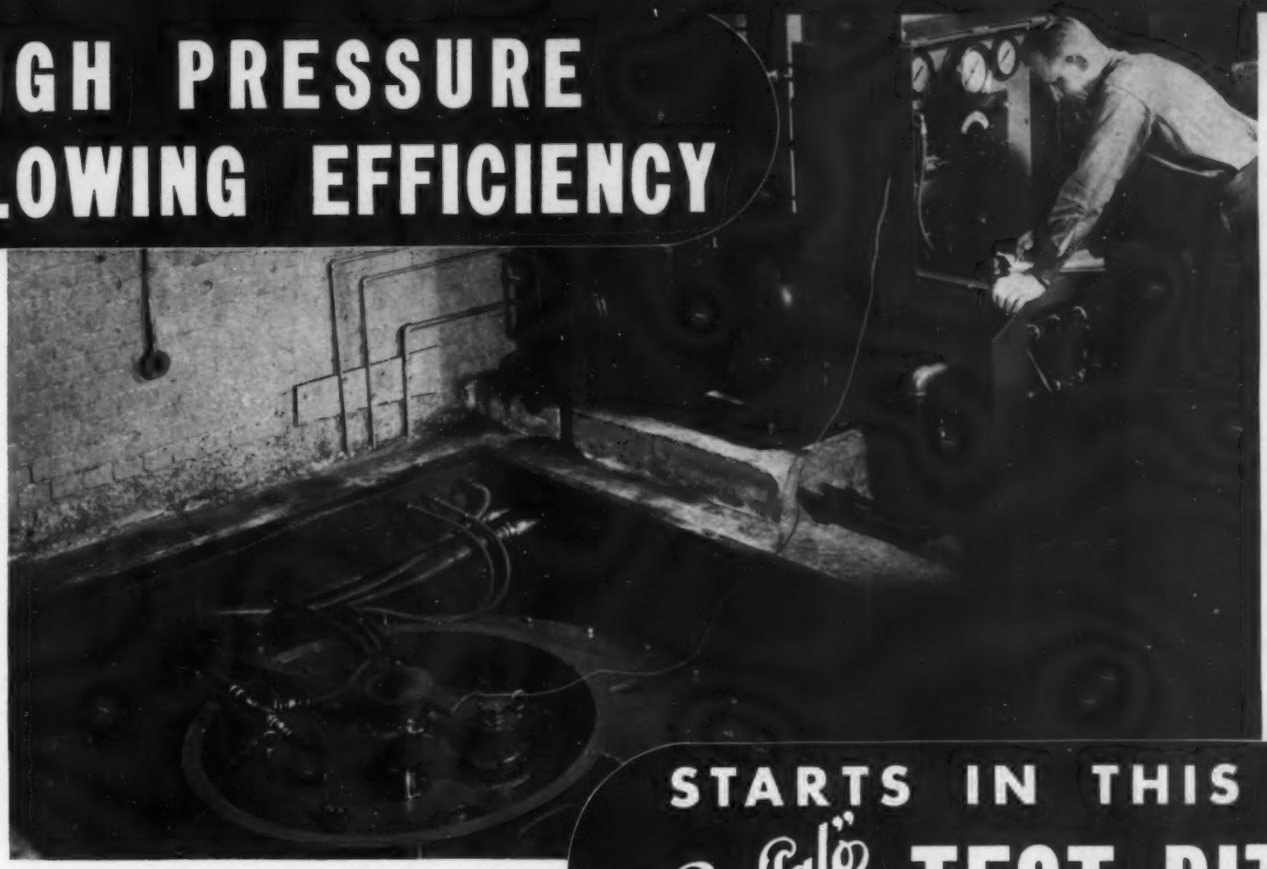

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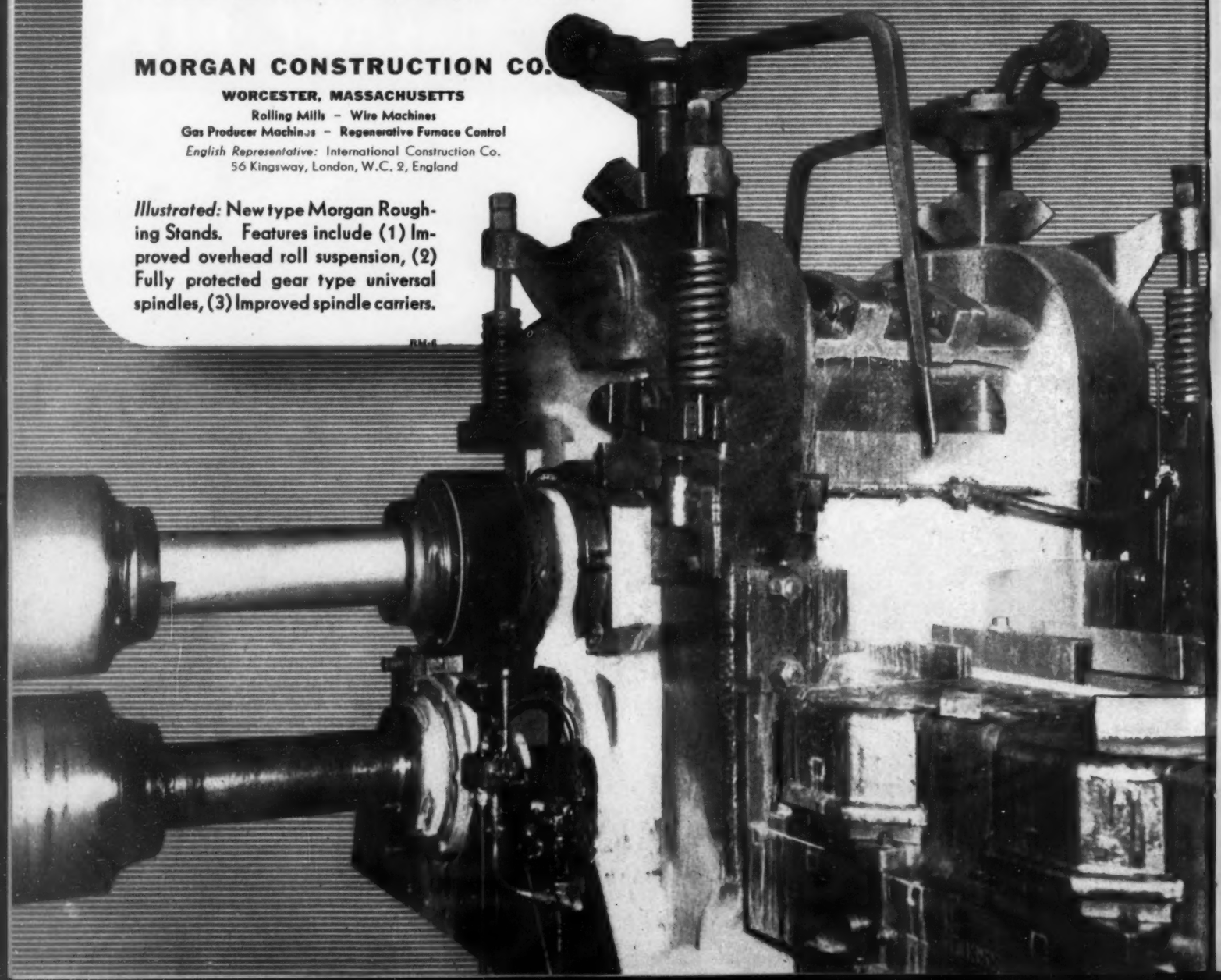
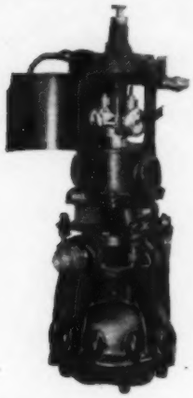


Accurate Measure And Control of Fuel Oil And Viscous Liquids



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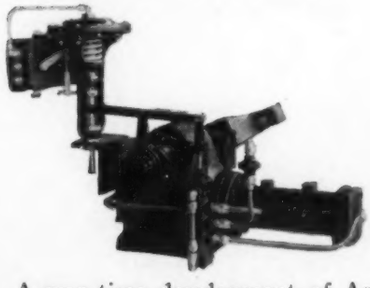


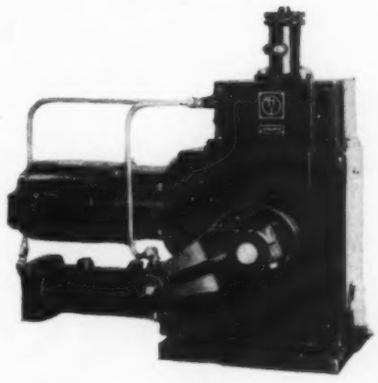
A war time development of Askania Regulator Company, 1603 South Michigan Avenue, Chicago, Illinois, is an oil operated hydraulic booster cylinder for air operated controllers. Using a standard diaphragm top it provides high power amplification and permits exact positioning of heavy dampers, valves and the like in accordance with the applied pneumatic loading pressure — usually 0-15 pounds p.s.i.

The cylinder may be of the crank type, as shown, or of the straight reciprocating type. Straight cylinders are available up to 8" bore and 30" stroke.

Other types of remote positioning cylinders are available using electric instead of pneumatic transmission.

★ ★

Complete Package Automatic Control In Single Unit



Can be applied to flow pressure [on Ratio Control

The Askania Regulator Company's Power Unit is a hydraulic crank type cylinder, whose operation can be controlled by most any type of air operated controller. The cylinder produces a crank arm stroke directly proportional to the loading pressure developed by the air operated controller. A change in loading pressure of one ounce and a bellows movement of only .0066 inches will start the crank arm in motion. Thus it can be operated from the primary relay of any air controller.

The unit is self contained, easily installed and prevents maintenance problems. Power units are available from stock, have an accuracy of crank arm positioning of plus or minus ½ degree. Heavy loads can be handled with ease and accuracy . . . .as the Power Unit is designed for heavy duty . . . with a stalling torque of 4000 inch pounds.

Askania Remote Position Servo System

The Askania Position Servo System consists of transmitter, electronic control amplifier, and receiver. Its purpose is to position accurately a remote load under the control of the transmitter.

Transmitter

The transmitter shaft may be positioned by hand, or may be connected to any equipment whose angular position is to be transmitted. The torque required to operate the transmitter is negligible.

Control Amplifier

Indicator lights on the amplifier panel show if energy is supplied to the receiver, and in which direction.

A signal system indicates at all times whether or not a pre-determined unbalance between transmitter and receiver is exceeded.

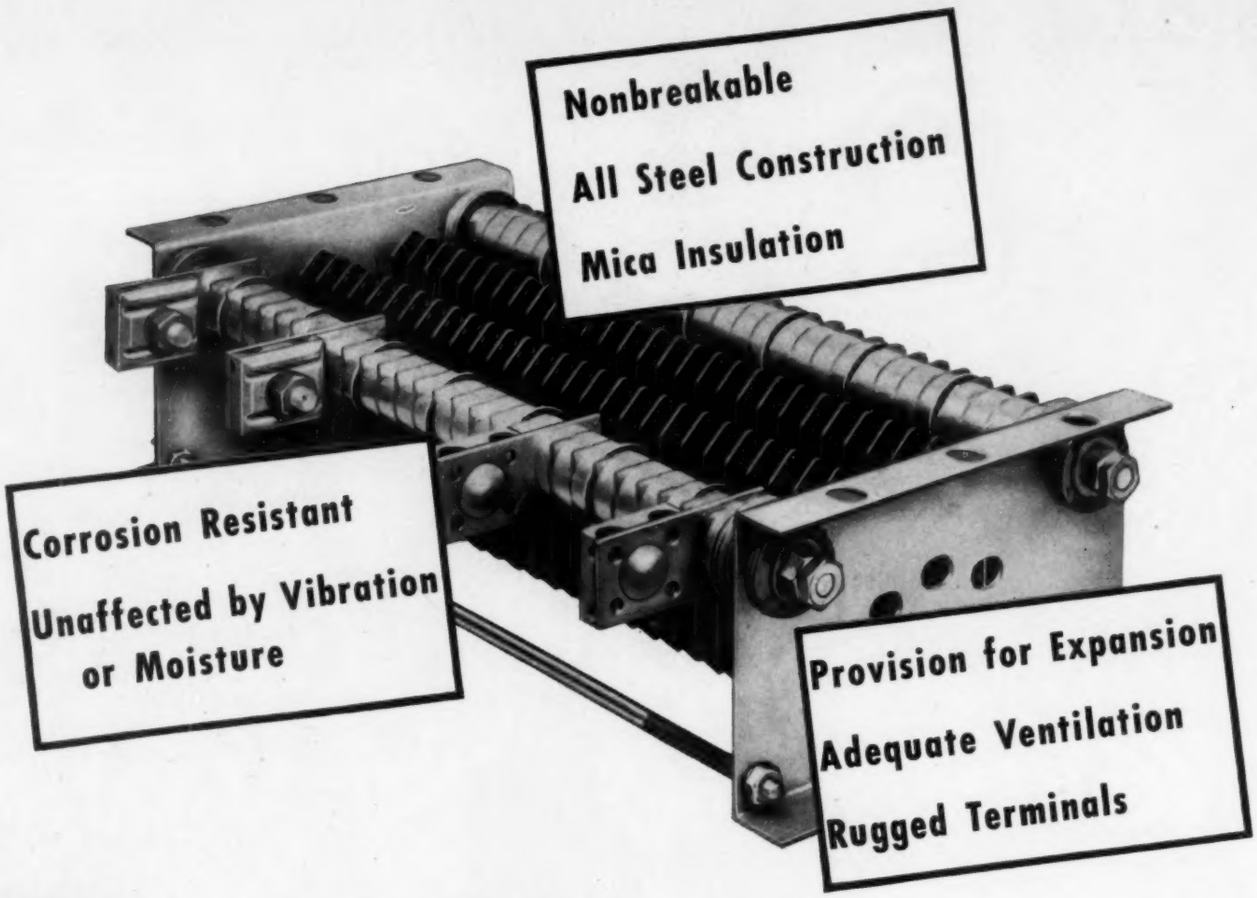
The amplifier panel may contain an "auxiliary transmitter" for manual positioning of the receiver.

Receiver

The receiver motor may be a small induction motor (no brushes or contacts) or, for heavy loads, an hydraulic motor capable of furnishing almost unlimited torque output. Accuracy of receiver position: ±0.1%.

Examples of Applications

Control of Bessemer converters from operator's pulpit; remote control of fuel to air ratio; remote setting of pressure regulators for open hearth furnaces.



Thoroughly TRIED AND PROVED!

P-G Steel Grid Resistors have four qualities vital to trouble-free resistor service. *All steel construction, mica insulation, provision for expansion, and ample ventilation* combine to produce the exceptional stamina necessary for long resistor life. In addition, P-G Resistors are not harmed by vibration, moisture or corrosive atmospheres. These characteristics coupled with correct resistance values and ample capacity ratings, assure longer resistor life, low upkeep and dependable performance. Try P-G on your next tough resistor application.

Write for Bulletin No. 500

P-G

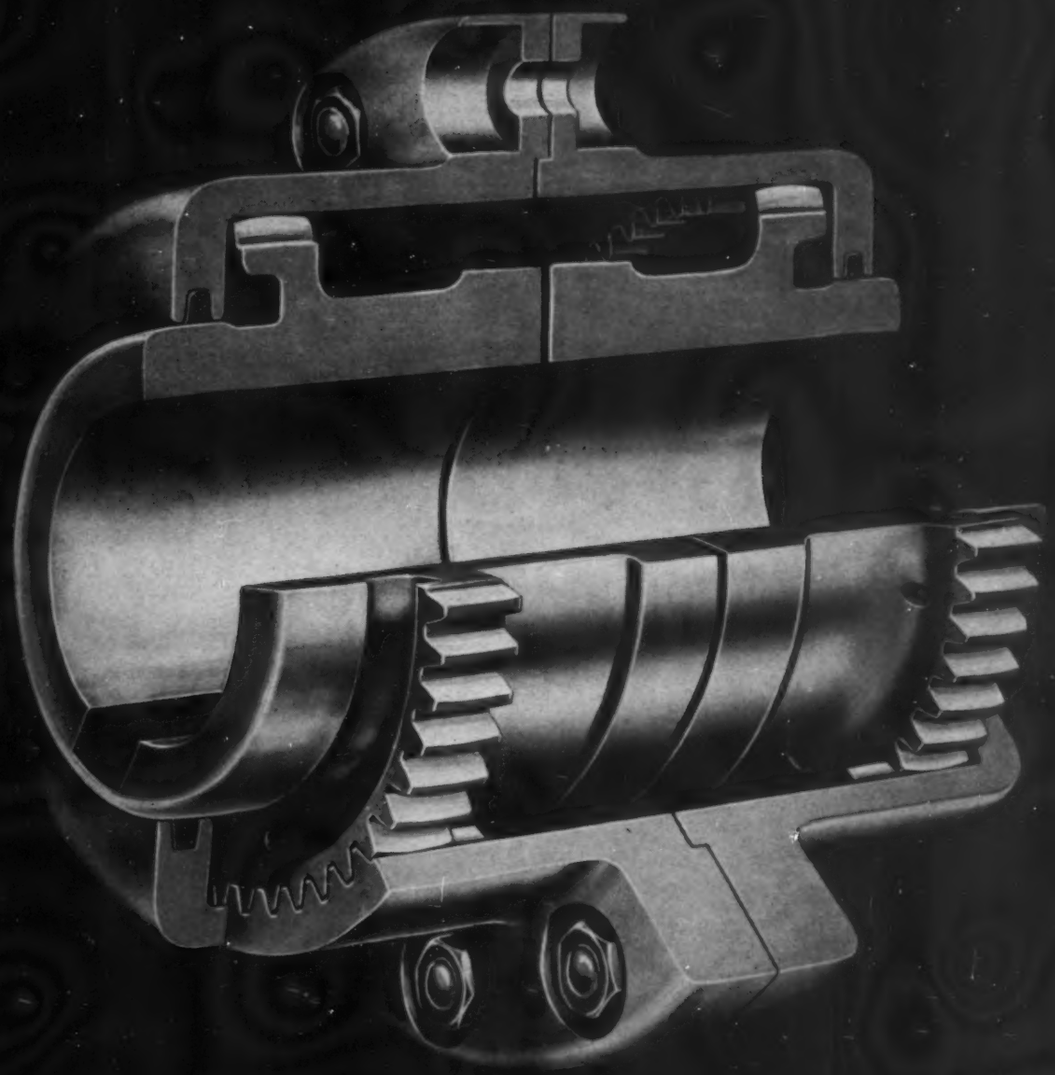
The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

When the Heat's On

ROCKBESTOS A.V.C.

The Heat's *Off* the

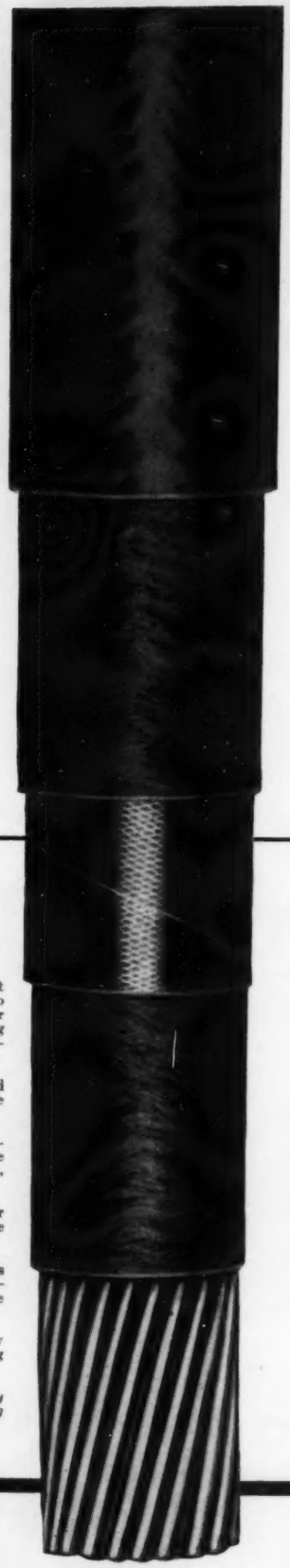
MAINTENANCE DEPARTMENT

Each hot-spot circuit that is wired with Rockbestos A.V.C. means one less headache for the maintenance department. Because heat — and we mean heat that may reach a blistering 230° F. — just doesn't bake the life out of these time-tested wires and cables.

If you want to *maintain* service instead of spending time and money trouble-shooting failures, specify Rockbestos A.V.C. wires and cables. They can take punishment in failure-making locations *year after year* because they are *permanently insulated* with impregnated asbestos to resist corrosive fumes, flame, oil, grease, or condensation resulting from heating and cooling cycles.

A wide range of standard types and sizes — including Rockbestos-designed types AVA, AVB, AVL and All-Asbestos insulated constructions — will take care of anything you need up to 5000 volt rating. For a catalog containing application data write to:

ROCKBESTOS PRODUCTS CORPORATION
167 Nicoll St., New Haven 4, Conn.



This Is the Construction that REDUCES MAINTENANCE

Type AVA, Rockbestos A.V.C. 600 Volt Power Cable to the right (No. 18 AWG to 2,000 MCM) and similarly insulated Motor Lead Cable have a maximum operating temperature of 230° F., and this failure-preventing construction:

Age-resistant impregnated asbestos braid that resists heat, flame, moisture, oil, grease and corrosive fumes.

Outer wall of felted asbestos insulation, impregnated with heat, flame and moisture resisting compounds, won't dry out, crack, flow, rot or burn.

Asbestos-protected varnished cambric for high dielectric strength and added moisture resistance.

Inner wall of impregnated felted asbestos withstands conductor-heating overloads — won't bake brittle or burn and helps provide greater current carrying capacity.

Conductor is perfectly and permanently centered in helically applied non-flowing insulation.

One of 125 different constructions designed by Rockbestos for severe or unusual operating conditions.

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK BUFFALO CLEVELAND CHICAGO PITTSBURGH DETROIT
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NEWS SUPPLEMENT December, 1946

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

CRUCIBLE STEEL LAUNCHES $30,000,000 PRODUCT DIVERSIFICATION PROGRAM

▲ A thirty million dollar program to diversify its products, consolidate operations and improve operating practices has been launched by Crucible Steel Company of America.

Approximately 40 per cent of the expenditure will go for facilities to produce hot and cold rolled steel sheets and strip in coils. The new rolling mills are designed primarily for production of hot and cold rolled stainless and other alloy steel sheets and strip, but the equipment may be utilized also for producing carbon steel sheets, strip and light plates.

The company now operates facilities for producing a limited tonnage of tool, specialty alloy and stainless steel sheets on its hand rolling mills but has no facilities for mechanized production of wide steel sheets.

Greatest portion of the expenditure will be made at the company's Midland, Pennsylvania, works. There at a cost of $20,850,000 the company will make improvements including installation of hot and cold finishing mills, bar and billet mill, 21 by-product coke ovens, and other new facilities.

At the company's Halcomb and Sanderson works, Syracuse, New York, will be a $3,300,000 program that will include a new melt shop, and new equipment to increase capacity of cold finishing facilities.

At the Park works, Pittsburgh, the company plans to spend $3,100,000 for improvements that will include two bar mills and a new specialty mill for rolling shapes and flats.

Improvements at the Spaulding and Jennings works, Jersey City, New Jersey, are estimated at $1,600,000.

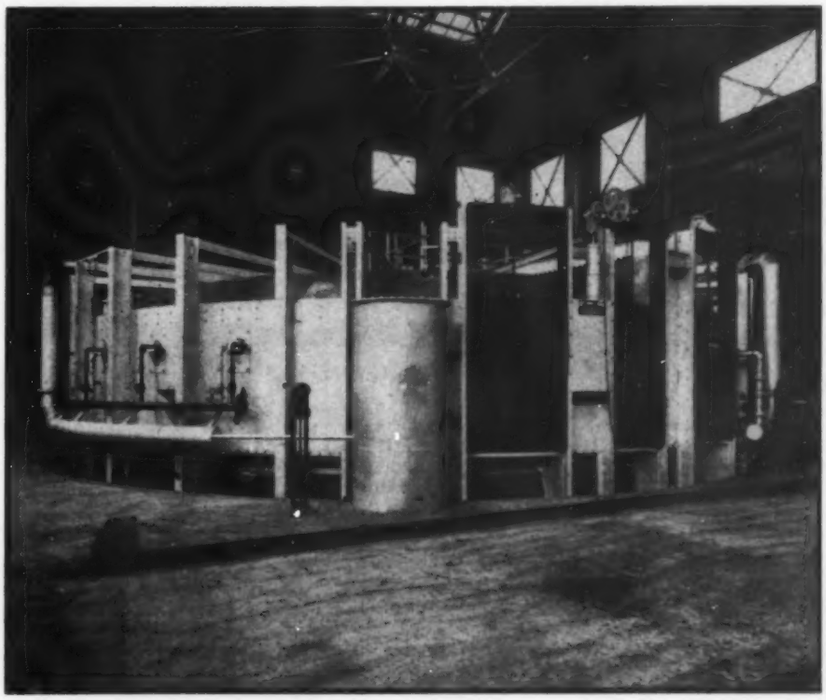
In addition, the program includes rehabilitation of the Spring works at Pittsburgh, acquisition of sites and construction of warehouses at Philadelphia and Chicago, purchase of additional barges, and other miscellaneous improvements. Cost of this portion of the program is estimated at approximately $1,150,000.

The entire program is expected to be completed by the end of 1948.

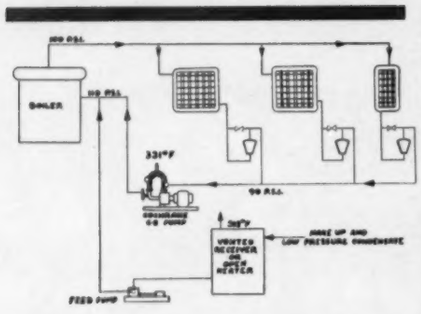
INDUSTRIAL SPACE HEATING WITH CONDENSATE RETURN

▲ In high pressure heating of commercial and industrial buildings, factories, foundries and warehouses, condensate from the blast heaters is usu-

ROTARY FURNACE WITH CENTER HOLE SAVES 50 PER CENT ON FUEL CONSUMPTION



This rotary furnace, designed by Rust Furnace Company to utilize the counter-flow principle of heating, reduces heat at the center of the doughnut hole and saves 50 per cent on fuel consumption. The cylinder in the center foreground is one of the waste gas outlets leading from the furnace to the stack. A similar outlet is directly opposite, inside the hole of the furnace.



Installation diagram of a typical high pressure condensate return system applied to space heating.

ally returned to a vented receiver or open heater. With unit heaters operating at 100 psi (pounds per square inch) this condensate leaves the heating coils at about 90 psi which corresponds to 331 F. Assuming a typical heating load as 100 gallons per minute (48,000 lb/hr), the loss of steam in flashing from 331 to 212 F in an open hot well would amount to 6240 lb/hr at the established rate of 13 per cent for this pressure differential. If steam can be generated at 32 cents a thousand pounds, which is a fairly economical cost, the loss of steam amounts to $48.00 in a 24-hour day.

In addition the remaining condensate, 41,760 lb/hr, in dropping from 331 F to 212 F loses 121 Btu/lb (from steam tables). This heat loss totals 5,050,000 Btu/hr and is equal to the amount of heat contained in 4250 lb of 100 psi steam. At 32 cents a thousand pounds the additional loss is $32.60 in a 24-hour day.

One method of recovering this heat is by returning the condensate at high temperature and high pressure directly to the boiler against boiler pressure as rapidly as it is formed. Ordinary feed pumps are not capable of handling the mixture of air and hot condensate. The condensate at close to vaporization temperature tends to flash and bind the pump.

In Cochrane Corporation's high pressure condensate return system a specially designed centrifugal pump draws water from the thermo-fin priming loop and discharges it as a high velocity jet through the jet pump nozzle. This jet strikes the returned hot condensate and induces condensate flow through the venturi-shaped mixing tube and into the thermo-fin priming loop. The additional volume of condensate introduced into the constantly filled loop results in the discharge of an equal volume through the air separator to the boiler.

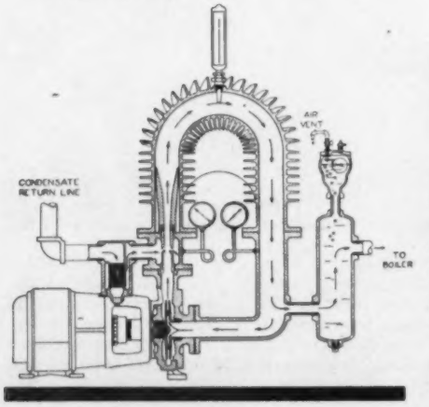
The hot condensate and entrained air are drawn rapidly and positively from the heating coils by the jet pump. Air is eliminated from the circuit by passing through the air separator and the condensate is returned to the boiler at maximum temperature and pressure. Thus, the circuit from boiler, through equipment, and back to boiler is completed in a closed system without substantial drop in temperature. Performance of the unit is verified by the pressure gauge on the inlet together with the pressure gauge and thermometer on the outlet.

The return system repays its cost several times over. In new systems, amount of radiation can be reduced due to the higher heat available from individual space heaters.

In a large foundry savings of $1635.00 were made in an average winter month on a 240 gpm heating load at 75 psi. A similar record is being obtained in a 125 psi system extending over a number of widely separated individual buildings with excessively long return lines.

——12-E-2——

Diagram showing flow of condensate through high pressure condensate return pump.



MAINTENANCE COST RISE CONTINUES UPWARD TREND

▲ The cost of keeping steel plants and their equipment in good running order rose during 1945 to a record figure of slightly more than $542,000,000, according to the American Iron and Steel Institute. The increase over 1944, a jump of about $3,000,000, marked the seventh successive year in which housekeeping costs within the industry have risen over the previous year.

It is believed that repair and maintenance costs during 1946 will also be high because it has been impossible to get replacements for some equipment that has passed its peak efficiency. Some of the money that was to have been spent in 1946 for an anticipated $327,000,000 expansion program for the industry has been diverted, instead, to repairs and maintenance of facilities that cannot be replaced because of material shortages.

In recent months as the iron and steel industry was turning out raw and finished steel in tonnages never before achieved in peacetime, repair and maintenance costs per ton of production were still high. In 1940, for example, such cost was $6.30 per ton of hot rolled iron and steel products. In 1945, the similar cost was $9.07 per ton.

Wages represent the largest single item in the expenditures for repairs and maintenance. Often overtime must be paid due to the fact that repairs have to be made at odd times.

BROOKS OIL BUILDS RESEARCH LABORATORY

▲ Brooks Oil Company announces completion of a $35,000 laboratory at the company's Cleveland, Ohio, plant, to increase facilities for research and for routine testing of Brooks "Leadolene" industrial lubricants. Within the last five years, Brooks laboratory facilities have been more than quadrupled.

Of special interest to industry are the 24-hour testing service and the monthly and semi-monthly inspection service offered by Brooks Oil Company to its customers. The 24-hour testing service, for example, enables users of large hydraulic and circulating oil systems, in which machinery

This new research laboratory offers monthly and semi-monthly inspection.

failure often introduces water and other contaminants, to obtain a report on lubricant condition within 24 hours. Monthly and semi-monthly inspection provides a constant check on lubricant purity and pH-ilm strength, lowering maintenance costs and preventing equipment damage.

Brooks "Leadolene" lubricants are individually compounded to meet the special requirements of each particular industrial job. Among the first companies to produce extreme pressure lubricants, Brooks Oil Company now offers "Leadolene," which maintains a minimum pressure of 25,000 psi, 5000 psi above the pH-ilm strength required for classification as an extreme pressure lubricant.

—12-E-3—

ALLEGHENY LUDLUM AWARDS PLANT OPERATING HEADS

▲ The Allegheny Ludlum award, a newly adopted form of recognition for "distinguished service and outstanding achievement" among executives and employees of Allegheny Ludlum Steel Corporation, has been presented to four men by Hiland G. Batcheller, company president.

At ceremonies following the company's regular board of directors' meeting, the award was presented to Vere B. Browne, vice president in charge of research and a member of the board; Walter M. Patterson, manager of the electric furnace department at the company's Brackenridge, Pennsylvania mill; David P. Bartell, chief chemist at Brackenridge, and Walter Miscosky, of the Brackenridge chemical laboratory.

While Mr. Browne and Mr. Patterson received individual awards, each of which consists of the "president's medal," a certificate, and a $1000 cash award, Mr. Bartell and Mr. Miscosky divided the third award for their joint "extraordinary accomplishments in reducing the time required to determine the chemical analysis of alloy steels."

Mr. Browne, who became associated with the Allegheny Steel Company in 1909 as chief chemist and rose to the position of vice president in 1930, was cited for "continuous contributions to the art of making magnetic, stainless and other alloy steels."

Mr. Patterson, 46, a graduate of the University of Pittsburgh, began

Mathews Methods *are paying*
DIVIDENDS

THE outstanding efficiency of manufacturers applying continuous flow handling methods provides proof that these methods are rendering real production service. Gravity and power conveyers and specially engineered conveying machinery usually are combined to make up Mathews Conveyer Systems. Such systems are an investment in greater output, lower costs, and improved employer-employee relations. The conveying equipment provides a steady flow of materials through processing machinery, and reduces manual handling and worker fatigue to a very minimum. It is designed to operate under severe service with very little maintenance attention, and into every section goes the finest of materials and manufacturing skill.

Mathews Engineers have acquired a wealth of experience in dealing with materials-handling problems. The benefit of this experience is readily available to you. Write or wire for field engineering service.

MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA
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work with the company as third helper in the open hearth department of the Brackenridge mills in 1922. He was honored for "continuous accomplishment in the field of electric furnace operations."

Mr. Bartell and Mr. Miscosky were honored for finding a means of obtaining more quickly the chemical analysis of alloy steels. Mr. Bartell, 45, joined the company in 1920. Mr. Miscosky, 38, has been with the organization since 1929.

HYDRAULIC SYSTEM FOR DIESEL-ELECTRIC DRIVE

▲ A new electro-hydraulic governing system for diesel-electric drives, readily adaptable for industrial uses where diesel-electric drives are employed, has been developed by the General Electric Company.

Designed especially for power plant load control, the salient features of the system are exceptional speed control with good stability, highly responsive to changes in generator demand and engine ability, engine protection, remote control and multiple-unit operation, according to G-E engineers.

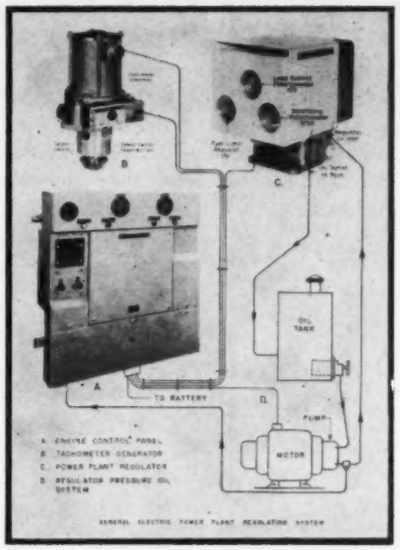


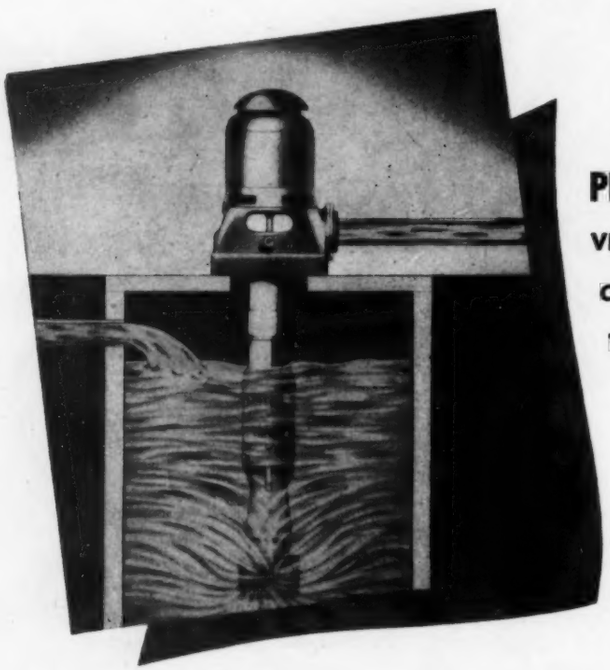
Diagram of the new electro-hydraulic system of diesel-electric drive.

Speed measurement is performed by an engine-driven a-c tachometer generator whose output voltage is proportional to speed. Speed is maintained at pre-set values, by feeding the speed indication to a hydraulic servo-mechanism which controls the engine fuel and generator excitation, and makes possible full utilization of the engine without danger of overloading.

The system operates stably over a wide speed range, and permits the use of the lowest possible engine speed commensurate with power requirements. The use of feedback from the electrical load allows the control to anticipate the speed changes which would be produced by changes in generator demand, and therefore minimizes transient regulation.

Engine protection safety features are built in this new governing system. Overspeed protection is provided by an overspeed trip switch which automatically cuts off the fuel supply when the engine overspeeds. If the engine lubricating oil pressure drops to the danger level, a short-circuiting switch drops the engine speed automatically to idle. Similar type switches, functioning with the same end

(*Please turn to page 123*)



PEERLESS
VERTICAL,
CLOSE-COUPLED
TURBINE PUMPS

PEERLESS PUMPS

FULL TURBINE PUMP UTILITY & CAPACITY
from Short or Medium Settings

Peerless Vertical, Close-Coupled Turbine Pumps offer a most efficient method of supplying and moving water from short settings. Ideal for installation over sumps, pits, basins, etc., where turbine pump utility and capacity are required. Capacities: From 15 to 30,000 G.P.M. For medium and high heads • Oil or water lubrication • Choice of Drives.

Request Bulletin B-159, describing the engineering, construction and application of Peerless Vertical Close-Coupled Turbine Pumps.

PEERLESS VERTICAL, *CLOSE-COUPLED* PUMP APPLICATIONS INCLUDE:
BOOSTING • RECIRCULATION • RESERVOIR PUMPING • REDISTRIBUTING • SETTLING AND CLARIFICATION • AIR CONDITIONING • CHEMICAL PROCESSING • WATER COOLING • MINE DEWATERING • COOLING TOWER

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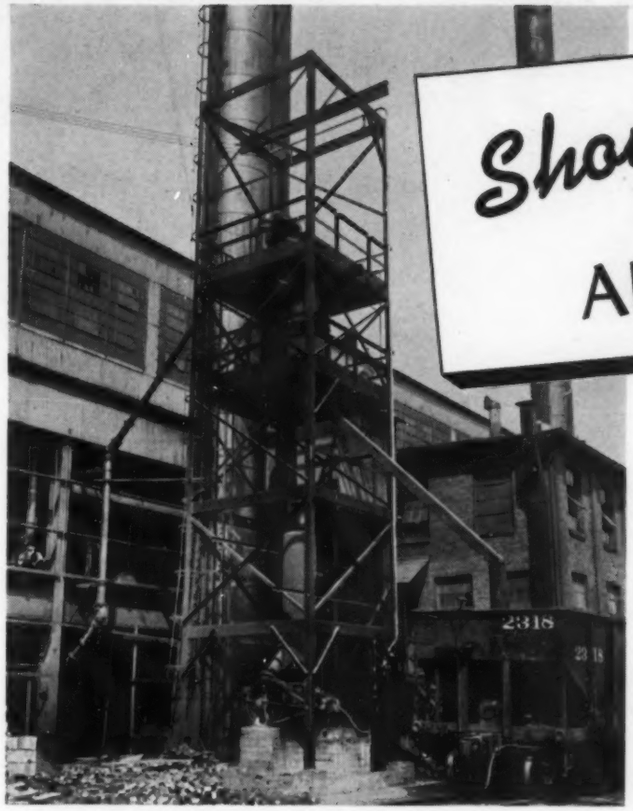


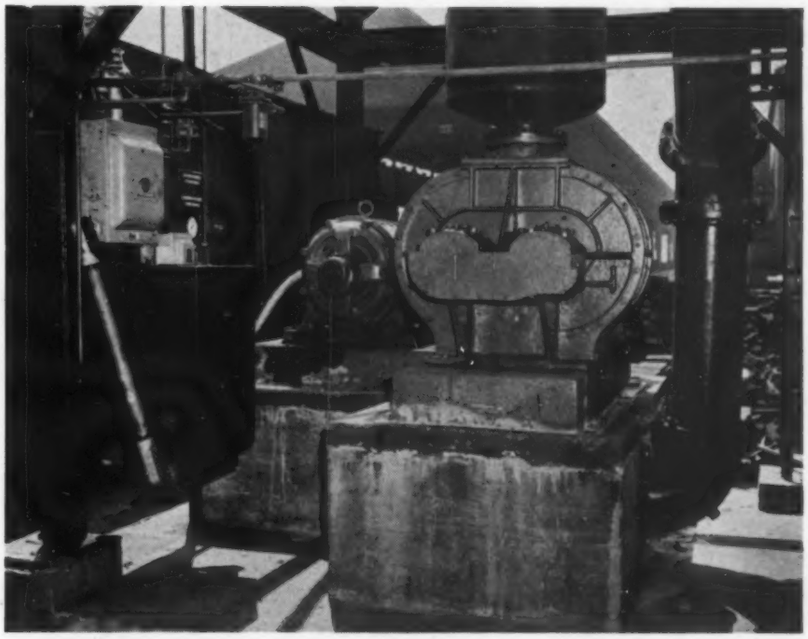
Showing A NEW ARRANGEMENT

of electro-blower VACUUM CONVEYOR SYSTEM *for open hearth flue dust removal*

A VACUUM CONVEYOR SYSTEM of the same type can also be used to solve your conveying problems if your plant is short of steam.

SAVE YOUR DOLLARS...
consult us

Our Engineering Service is always ready to discuss and help you solve your problems

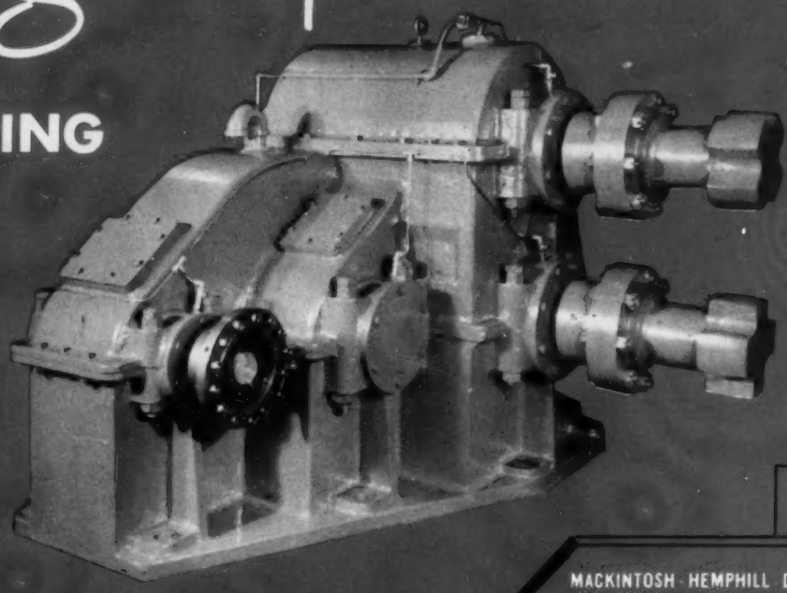


THE VACUUM CONVEYOR COMPANY

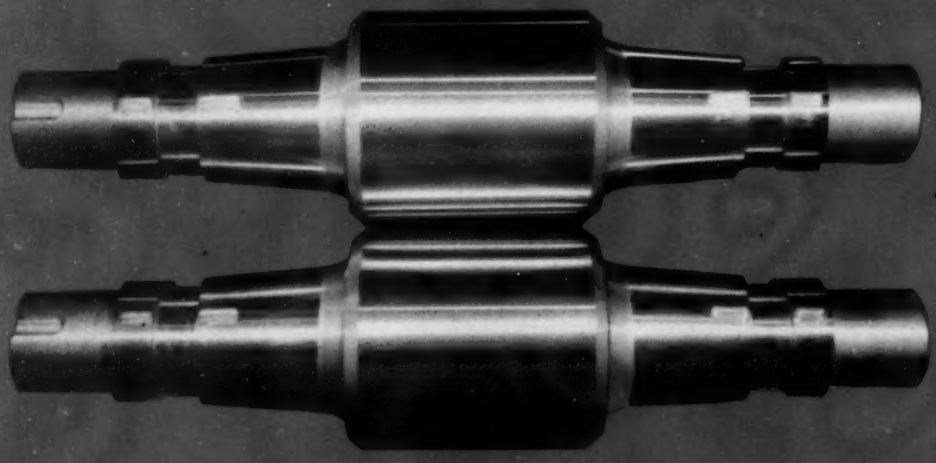
MAIN OFFICES: CURREN ARCADE BUILDING, NORRISTOWN, PENNA.

SALES REPRESENTATIVES: **PHILADELPHIA, PA. PITTSBURGH, PA. GARY, IND**

8 guideposts to PRODUCTIONEERING



MACKINTOSH-HEMPHILL DRIVES transmit power for industry's metal rolling mills.



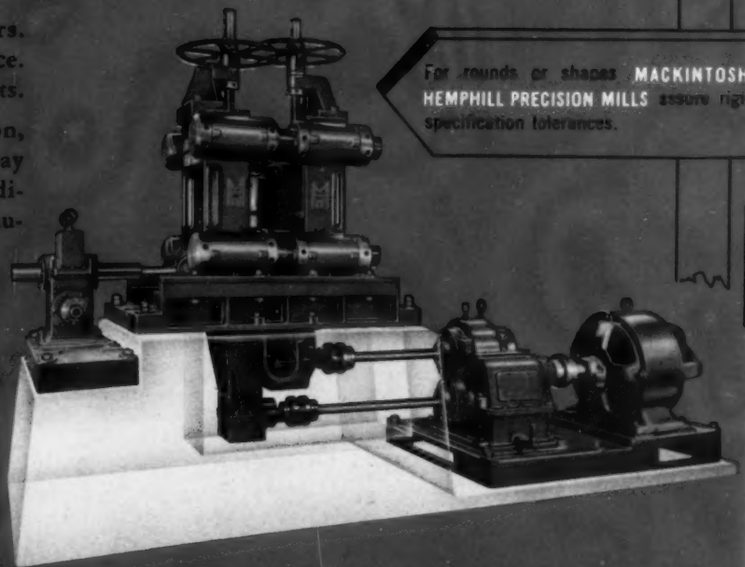
ROLLS WITH THE RED WABBLERS will make short work of your production rolling operations.

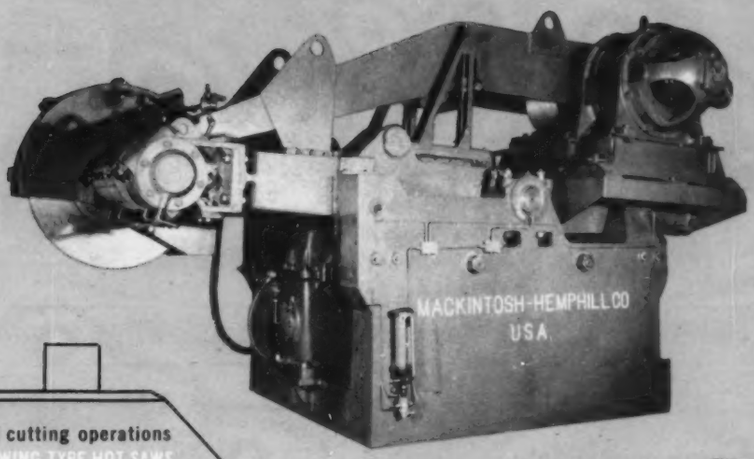
MACKINTOSH-HEMPHILL facilities for the design and construction of heavy industrial machinery include:

- A competent staff of experienced engineers.
- Metallurgists trained in metal mill practice.
- Two completely manned manufacturing plants.

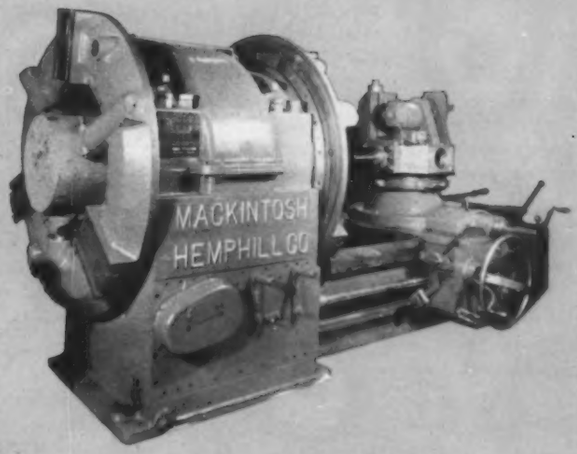
In the present-day struggle with competition, higher costs, and lost productive time it will pay to keep your eye on what's new in the widely diversified types of production machinery manufactured by MACKINTOSH-HEMPHILL.

For rounds or shapes MACKINTOSH HEMPHILL PRECISION MILLS assure rigid specification tolerances.

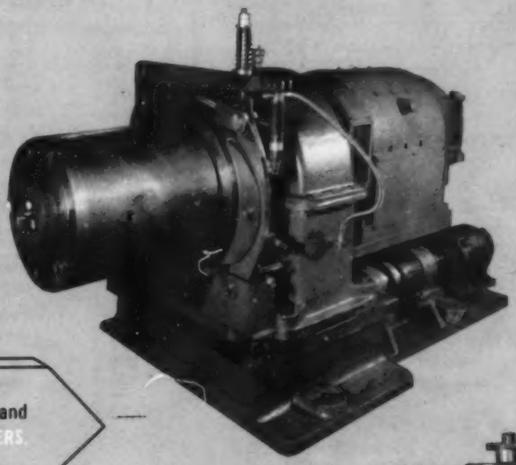




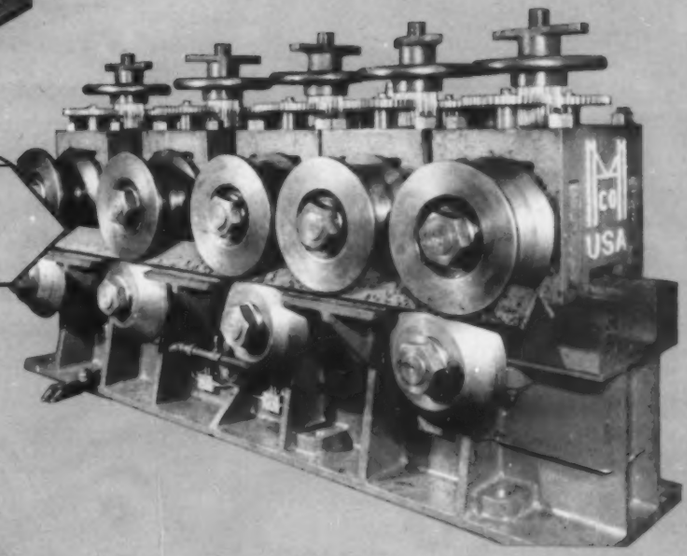
For high-speed cutting operations there are M-H SWING TYPE HOT SAWS and many types of shears.



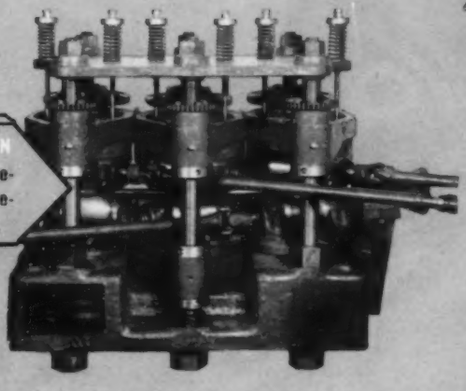
M-H HOLLOW-SPINDLE TURRET LATHES, together with heavy-duty lathes of many types, fulfill many special productioneering requirements.



For all types of metals, in all widths and coil weights, there are M-H STRIP COILERS.



There are M-H ANGLE AND SHAPE STRAIGHTENERS, too, in the M-H catalog of metal straightening equipment.



MACKINTOSH-ABRAMSEN STRAIGHTENERS leave no score-marks on finished products, require minimum setting-up time.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH · MIDLAND, PA.

Makers of the rolls with the red wabblers

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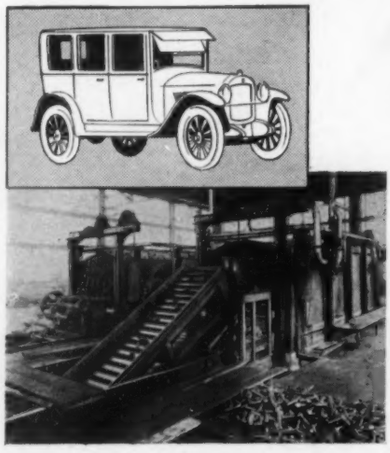
ISSUED MONTHLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

23 Years Ago...an R-S "First" which Started an Era

Old hands in the American Society for Metals (then called the Steel Treaters) will remember this particularly famous group of 1923 furnaces. The Bureau of Mines took movies of them; "Mike" Watson, metallurgist for the user company (American Gear & Mfg. Div. of Hupp Motors) toured ASM chapters and technical colleges giving speeches about them; and Professor Trinks wrote the details of their design into his now-famous



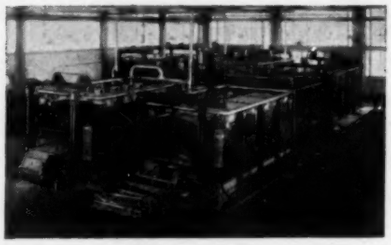
texts (see, Industrial Furnaces, Vol. II, 2nd ed., Figs. 250, 253, 256 and 279).

Why so famous?

Well, Sir, this family of four R-S furnaces made up *the very first continuous, automatic heat treating line for automotive parts*—and started the era of production-line heat treating we know today.

Here's the job they did. They took an endless stream of Hupmobile steering-knuckles and axle forgings through the harden-quench-and-draw cycle by fully mechanized means. The axle hardening furnace was an early walking-beam type. Other units in the line employed chain-conveyor and continuous-belt handling. All were oil fired. Temperature control was automatic. In fact, so young was automatic temperature control in 1923 that R-S had to build the control valve itself—one of the first such valves.

Our point is this! R-S has been around for a long time—with progressive, but practical, design sense of the brand that



makes improved production ideas work.

And if you study the photos closely, you'll see that the same principles of construction (geared door hoists, chain take-ups, ample expansion provisions, etc.) which characterize good furnace design today, characterized R-S methods 'way back in the early days of 1923.

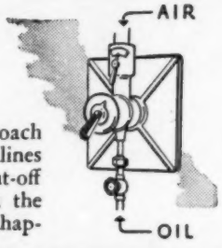
ON BUYING FACTORY-BUILT FURNACES

A furnace not built on your premises
May become, without warning, a nemesis.
Hidden faults of erection
May pass your inspection,
And assert themselves later—with emphasis.

But buy it, instead, from R-S,
And its "insides" you won't have to guess.
You can kibitz the making;
See the care we are taking
To keep year-round maintenance less.

Furnace men seem to like limericks that have to do with the business. Since starting to print them this Fall (see the October and November FURNACE FACTS), we find that there are several "bards-of-the-craft". If you're limerick-looney too, send in your contributions. We'll print them.

Tip on Oil Burner Piping



Be sure that oil branch lines approach burners *from below*. Let the air lines come down from above. Then, if shut-off valves leak or jam, drainage is in the right direction. Imagine what could happen when you light your furnace after oil has leaked *into* the furnace chamber during periods of shut-down.

It's details like this which have earned the respect the R-S nameplate enjoys.

...and Here's the Man Who Designed Them

Meet our own vice president and chief engineer, D. E. Wyman, who designed

the Hupp axle and knuckle furnaces which started the era of continuous sequence heat treatment above discussed.

For those who don't yet know Mr. Wyman, despite 33 years in industrial furnace design, it will be worth noting that, in addition to being the father of the famous Hupp harden-quench-and-draw lines of 1923, he designed the Navy's first ordnance furnaces at Pearl Harbor; led the R-S engineering crew during two world wars; is an authority on rotary, pusher and conveyor furnace construction; knows how products behave under heat (from copper spark-plug gaskets in the annealing range to forging ingots at 2300°F or hundred-ton weldments being stress relieved); and has done outstanding development work on materials handling mechanisms for high temperature service.

Since 1913 he's been active at metalmen's meetings and furnace-men's round-ups—but mostly he's home at R-S in Philadelphia working for you—making good furnaces better.

JML oo P-MI

(*Continued from page 118*)

result, operate at dangerously high temperatures or on occurrence of a ground in the main power circuit.

Remote control in this system is readily achieved. The manual and automatic controls may be located at any desired distance from the prime mover. Speed modulation can be infinite or by definite steps as in throttle notches. The engine-speed indicator is remote from the fuel control. Multiple-unit operation, as in the case of diesel-electric locomotives, is readily accomplished.

—12-E-4—

ELECTRONIC X-RAY GAGE FOR CHECKING THICKNESS

▲ A remarkable new gauging instrument known as the "Measuray" is now being offered to industry by the Sheffield Corporation which has acquired exclusive manufacturing and sales rights. It utilizes an entirely new X-ray and electronic application for non-contact, continuous or spot checking of thickness of all types of moving materials.

The "Measuray" can be applied to almost any production process where it is desired to measure and regulate the thickness of material. Accuracy can be held to better than one per cent of material being checked if required. It is suitable for use with brass, copper, steel, aluminum or any other metal; paper, plastics, composition material, film, rubber, cellophane in the form of sheets, or foil of any kind. Metal foil can be checked for thickness to an accuracy of one per cent just as easily as sheet materials $\frac{3}{16}$ in. thick. Concentricity can likewise be checked to measure a wire surrounded by insulation.

Tolerance and thickness limitations are dependent to some extent on the density of the material to be checked. Precise accuracy is maintained regardless of whatever changes may occur in the product. Speed of movement of material, whether at the rate of 5 feet or 5000 feet per minute, has no effect on the accuracy of the gauging instrument—neither does the temperature of the room, nor of the stock. For example, sheets or strips coming hot from the rolls give the same indication on the "Measuray" when cooled to room temperature. Day after day uniform readings are obtained because of the in-built stability of the system employed.

The instrument utilizes masters of the same material to be checked for set-up and operating purposes. It compares the thickness of material with a sample of the same material which has the required known dimension. The variations of thickness are indicated in percentages. Standard units are equipped with indicating mechanisms, while recording and machine control devices are available.

No contact is required with the material to be gauged, and in some cases the nearest approach of any mechanical part of the instrument can be many inches away. Therefore, expensive destructive inspection is eliminated. Tests can be made at various points in the process to control any operation.

This new instrument can be applied to almost any production process where it is desired to regulate thickness.

—12-E-5—

60-DEGREE TWIST RAISES CHAIN LIFE EXPECTANCY

▲ The S. G. Taylor Chain Company of Hammond, Indiana, announces a new, patented triple magnet chain that is said to deliver three times as much life as conventional magnet chains now in use.

This important contribution to material handling is accomplished by incorporating a 60-degree twist in two of the three connecting links, which serves to keep the links of the legs perpendicular to each other. Wear caused from gouging and kinking is therefore reduced to a minimum Extra safety is built into these chains by the use of Taylor's special-analysis alloy steel which has 100 per cent more tensile strength than low-carbon steel or wrought iron. Its resistance to shock, grain growth and work hardness eliminates the need of periodic heat-treatment.

The 60-degree twist in two of the three links keeps the links of the legs perpendicular.

—12-E-6—

"ELECTROFLUID" DRIVE HAS DIRECT CONNECTION

▲ Following prolonged satisfactory use on a variety of installations, Link-Belt Company announces the development of a new and revolutionary type of "packaged" power unit, to be known as "Electrofluid" drive. It is presently available in horsepowers up to 20. The drive is a neat, compact, motorized hydraulic combination consisting of a general-purpose a-c induction motor flange-mounted on a sturdy housing containing a hydraulic coupling, also called "fluid coupling." Its output shaft may be direct-connected to the driven machine or to a speed reducer unit. It may also be connected to driven machine through the medium of chain, gear or belt drives.

Each fluid coupling has a primary and a secondary element. The primary element may be likened to a centrifugal-pump impeller and the secondary, or output element, to a waterwheel or runner. The coupling is filled with a light mineral oil of steam-turbine quality. When the motor drives the impeller, it causes oil to flow through the runner buckets back to the impeller, thereby rotating the runner

through the medium of the oil. The torque of the motor is transmitted from impeller to runner by the fluid in the coupling. There is no mechanical connection between the two elements of the fluid coupling. In effect, the fluid coupling inserted between the motor and its load serves as an automatic clutch, with the fluid acting as a "cushion" between prime mover and driven machine.

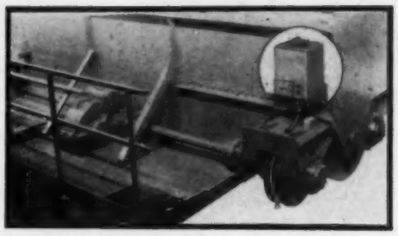
Without need of any complicated starting control or special type of motor, the drive has ideally solved the problem of inadequate torque and excessive high starting current peaks. Regardless of the characteristics or inertia of driven machine or connected load, the motor of the drive starts at no-load, because at zero speed the torque transmitting capacity of the fluid coupling is zero. The motor accelerates quickly, developing torque in the fluid coupling in the ratio of the square of the speed until sufficient torque up to the maximum running torque of the motor is developed to start the driven load.

—12-E-7—

INCREASE CAPACITY OF CRANE SANDER BY HALF

▲ On overhead, gantry, jib and other types of cranes operating on rails, Lintern electro-magnetic traction sanders provide sand instantly when needed on the rail directly in front of each driving wheel. These sanders speed up production, reduce flange wear and misalignment by giving maximum traction at all times.

Hoppers, containing a liberal supply of sand, are located above the driving wheels, operated by a switch



This improved sander has 50 per cent greater sand capacity than previous models. It is filled by removing a tight fitting circular cap on the cover.

located in the cab. Piped to the rail, the sand is directed at this point by a patented rubber nozzle. Special size hoppers are available with double outlets where the sanding of two rails, such as on gantry cranes, from one hopper, is desired.

The sand is heated continuously by a dependable strip heater enclosed between the inner and outer jacket, the sand is kept dry at all times, ready for use.

Coils and switch are built heavy to handle voltage variations and continuous duty. Any voltage coil is available and as many as eight sanders can be operated from the one switch. The design reflects twenty years of manufacture, insuring satisfactory service.

—12-E-8—

WELDING ALLOY PROVIDES HIGH WELD AT LOW MELT

▲ The need for a welding alloy that will provide high strength welds on ferrous and non-ferrous metals at an exceedingly low melting point has been met by the research department of the Eutectic Welding Alloys Corporation. Known as "EutecRod 1801," this alloy is the latest addition to the

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Simply mark the reference number on the coupon, complete your address data and return to us.

line of low temperature welding alloys produced by this company.

Applied by the oxyacetylene torch, furnace, or high frequency induction heating equipment, it bonds at base metal temperatures of 940 to 1120 F, and melts at 1143 F. This low melting temperature makes it possible to produce superior welded joints at new low costs. At this temperature, it will flow freely into close-fitting joints due to its extremely high capillary action. In addition, weld deposits will have a shear strength of 120,000 psi, good corrosion resistance and good electrical conductivity. This welding rod is available in rod, wire, strip, and powder form.

——12-E-9——

GENERAL ELECTRIC LICENSING BETATRON

▲ All seven of the General Electric Company's issued patents on the 100,000,000-volt betatron, world's largest and most powerful atom-smashing machine, have now been entered on the register of patents available for licensing, published in the Official Gazette of the United States Patent Office.

Explaining the company's licensing policy, Dr. C. G. Suits, vice president and director of the research laboratory, said that under these patents educational and other nonprofit organizations will be granted, upon request, free, nonexclusive licenses to build and use these giant machines on a nonprofit basis.

General Electric also grants nonexclusive licenses to industrial concerns "on a reasonable royalty basis to manufacture, use and sell betatrons."

A manufacturing license on a royalty basis already has been granted to the Allis-Chalmers Manufacturing Company, according to the General Electric vice president.

The Manhattan District project of the Army Engineers, which developed the atomic bomb, ordered a 100,000,000-volt machine from General Electric last spring for the Clinton Laboratory in Oak Ridge, Tennessee. Another has been ordered by the University of Chicago. Both will be employed for nuclear research.

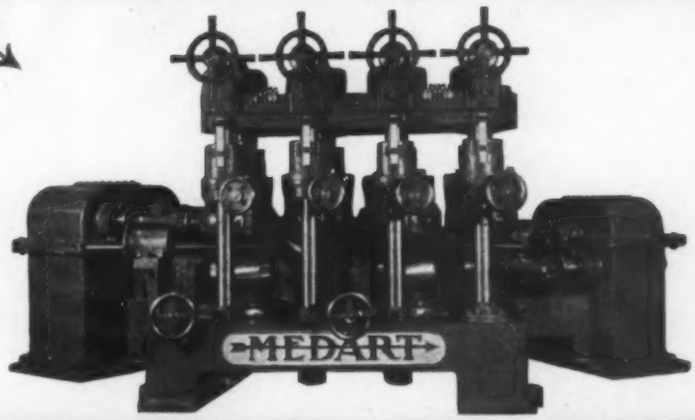
The first giant betatron consists of a 130-ton electro-magnet, which sur-

MEDART MULTICYCLE
PIPE AND TUBE STRAIGHTENING MACHINE

"6 in 1"
SIX POINTS OF SUPERIORITY IN ONE

1. MULTICYCLE STRAIGHTENING—Two bending rolls impose duplex straightening cycles on workpiece insuring end to end straightness.
2. POSITIVE AND SYNCHRONIZED FEED—All four feed rolls are driven insuring positive synchronized feed and torque balanced around neutral axis of workpiece.
3. THE WORKPIECE LEVEL—Maintains one feeding level for all sizes of pipes or tubes—eliminates need of adjustable entry and delivery tables.
4. NO GUIDES—Horizontal position of the six rolls with balanced torque eliminates requirement for guides.
5. SINGLE MOTOR—All four driven rolls powered from a single motor, for synchronization and economy.
6. NO BEVEL GEARS—All gears enclosed in cases and running in oil, for sure trouble free operation.

"Patents make Jobs"



MEDART

rounds a doughnut-shaped glass vacuum tube in which electrons are accelerated until X-rays of 100,000,000 electron volts are produced. It is located here in a special building with concrete walls three feet thick, as a protection from the dangerous rays given off.

The betatron was built under the direct supervision of Dr. E. E. Charlton and W. F. Westendorp of the G-E Research Laboratory. It was placed in operation during the summer of 1943, but government secrecy regulations on all work related to nuclear physics prevented public announcement until October, 1945.

—12-E-10—

FIND CHEMICAL INERTNESS IN COATING SOLUTION

▲ A new solution for the coating of electro-plating and pickling racks has been developed by The B. F. Goodrich Company which embodies the well-known chemical inertness of "Koroseal" tank lining. The new product is known as "Korolac RX-2500."

A second new development, known as "Korolac Primer No. A-208-B," is used in conjunction with the new product, to provide adhesion of the coating to the metal rack. This primer is brushed onto the rack and areas adjacent to the contact points, thereby preventing contamination of plating baths by carry-over of solutions underneath the protective rack coating.

The new coating is white, opaque, and glossy. Hot alcoholic reverse current cleaners and such oxidizing acids as chromic and 40 per cent nitric have little or no effect. The resistance to organic solvent cleaners is also remarkably good.

—12-E-11—

FURNACE DOOR GIVES FULL HEARTH AREA USE

▲ An "All-Door" furnace front for open-hearth furnaces, or for reheating furnaces, is said to promise a number of operating benefits, according to the designers of tilt-lift fronts — Frazier-Simplex, Inc.

Because this front completely eliminates door frames, buckstays between doors, and refractory door jambs, it is possible to open up the entire hearth area for use.

Substitution of the new, rolling doors for sliding doors does away with sticking and with abrasive rubbing of the door lining on the lintel or door frame.

The new doors do not have water-cooled edges. Exposed water cooling on this type door front, as compared with sprung-arch-type door frames, is 40 per cent less, thus offering savings in heat. Moreover, the new truck-operated-type doors have a supported lining twice as thick as the conventional refractory door lining, thereby increasing service life.

On the "All-Door" front, a two-point support makes each door lean toward the furnace at all times, and when it contacts the door sill it must naturally fall against the door lintel. The doors, individually opened or closed, have ample clearance between

The IMO PUMP provides a maximum of capacity in a minimum of space due to the fact that it can be operated at high speeds connected directly to motor, turbine or other machinery.

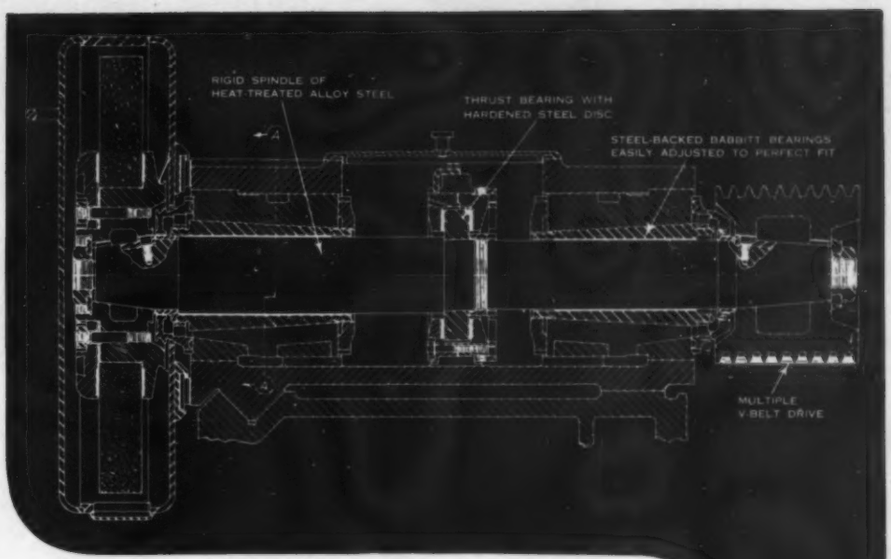
Where space is a problem install IMO—the reliable rotary, positive displacement pump having only three moving parts and no gears, pistons, sliding vanes or valves.

For further information send for catalog I-129 - I

IMO means I MOVE OIL

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

WHAT gives a FARREL Roll Grinder its PRECISIONABILITY?


RIGID SPINDLE OF HEAT-TREATED ALLOY STEEL
THRUST BEARING WITH HARDENED STEEL DISC
STEEL-BACKED BABBITT BEARINGS EASILY ADJUSTED TO PERFECT FIT
MULTIPLE V-BELT DRIVE

One of the main reasons for a Farrel roll grinder's outstanding ability to produce fine precision work is the construction and mounting of the grinding wheel spindle. Careful engineering and precise workmanship at this vital point pay off in the flawless mirror finish that can be produced consecutively on any number of rolls.

The spindle itself is of large diameter to assure rigidity under working load. It is made of high grade alloy steel, carefully machined, heat-treated and finally ground to extremely close limits.

The spindle is mounted in tapered, babbitt-lined, steel-backed bearings which are split longitudinally, and fitted with a locking wedge. Running clearance is easily controlled by adjusting collars at both ends of each bearing. Bearings are precision finished to assure perfect fit and alignment.

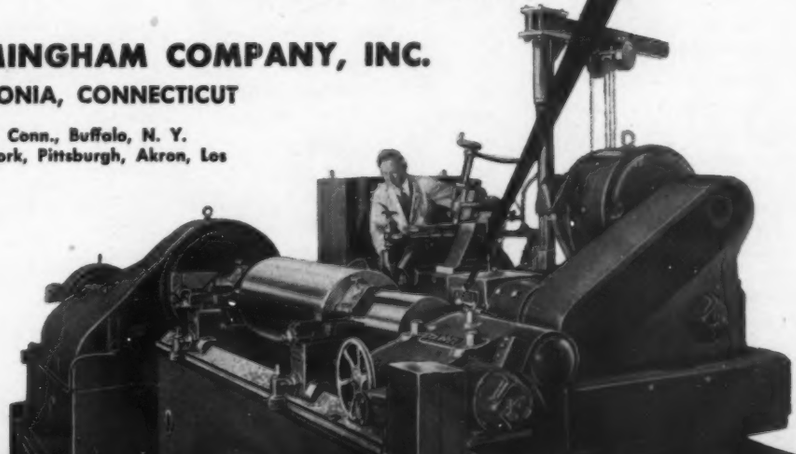
Thrust is taken by a hardened steel disc and two babbitted rings at the center of the spindle. This permits free expansion of the spindle bearings and insures less deflection of the spindle than would occur if the thrust bearing were at the end.

The spindle is driven by multiple V-belts, which operate with little tension, permitting closer clearance in the spindle bearings and consequently producing greater accuracy in the work.

If you have a roll grinding problem where accuracy of finish is vital, write for complete detailed information about Farrel roll grinders, either type TT (traveling work table) or type HD (heavy duty). No obligation.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Tulsa, Houston, Charlotte



FB-303

Farrel-Birmingham

each other. The space is closed by a refractory-lined seal that rides up and down on whichever door is uppermost. Flanged truck wheels guide each door up and down in one plane, thus preventing any door from "walking" into the lining of adjacent doors.

—12-E-12—

NEW REGULATOR REDUCES BATTERY CHARGE EXPENSE

▲ Battery-powered industrial trucks, tractors and locomotives have established a record of outstanding performance in the steel industry. These trucks are now the core of the flow of materials in most of the major mills. By reducing overall handling expenses, they lower the unit cost of production which is the only sure method of assuring profits in good times and bad. The batteries in these trucks have proved to be the most dependable and economical source of power.

Inadequate or unsuitable charging facilities will inevitably shorten battery life, increase maintenance costs and make impossible the maximum service from the trucks. The battery charger is not just another piece of equipment required for the materials handling system. It is the "core" of the whole operation. It controls the operating continuity of a dollar investment, many times greater than itself. Modern plant production and profits depend upon the constant availability of the trucks.

With the adoption by the steel industry of large fleets of battery-powered trucks, new problems were introduced in the design and application of the most suitable and satisfactory charging equipment. In the first place, batteries are worked hard in this service. Secondly, the greater the number of batteries to be charged, the greater the variation in age and general condition. Therefore, the greater is the need of more accurate control of the charging rates. Also the variations in physical location introduce variables in the total resistance from charger to the batteries, requiring special compensation.

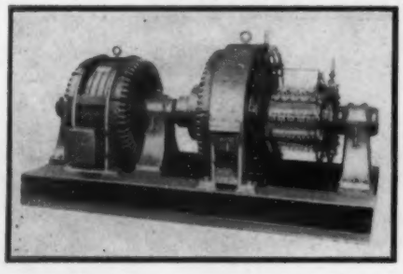
By taking advantage of an inherent characteristic of the diverter-pole type generator, the Electric Products Company has developed and has in successful operation a regulation system which has the following advantages:

1. Inherent voltage regulation at any point on the circuit with extremely close tolerance at very low cost.
2. A standard diverter-pole battery charging generator is used which is perfectly satisfactory for charging if the regulator should fail.
3. Ideally adapted to automatic paralleling of two or more machines to equalize wear, provide greater safety factor, and higher charging efficiency.

The real measure of value from this system is not entirely tangible but can be added up in longer individual battery life and a more dependable and accurate power supply for charging.

—12-E-13—

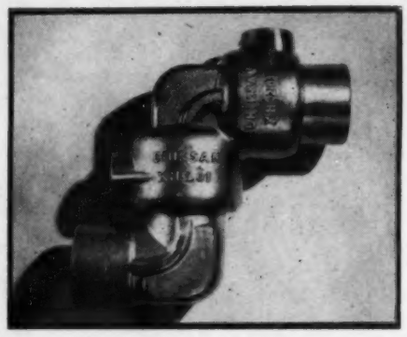
By using an inherent characteristic of the diverter-pole generator a remarkable new regulator has been developed.



CONSTRUCT SWIVEL JOINT FOR 12,000 PSI PRESSURE

▲ The new Chiksan "XH" (extra high pressure) swivel joint is built for working pressures of 12,000 psi and provides the same low torque, and positive packing seal-off associated with all of this company's swivel joints since their inception. Rotating members are steel forgings, machined to close tolerances and with flame-hardened ball races. Full 360 degrees rotation with low torque takes place on two rows of hardened steel balls which also serve to hold the rotating members together under pre-regulated pressure. The packing element is specially designed for high pressure service and is self-adjusting.

As in all of Chiksan's ball-bearing swivel joints, the new type employs no bolted flanges, locking rings or stuffing boxes. There is nothing to tighten or adjust. High pressure lubricating fittings provide for positive lubrication of the bearings. Inside diameter is unobstructed, permitting full flow of liquids, gases and vapors with minimum friction loss and turbulence. End connections are of the high pressure, tapered thread type. The new type swivel joint is recommended for all high pressure services to 12,000 psi.



This swivel joint employs no bolted flanges, locking rings, or stuffing boxes.

—12-E-14—

SKF BEARINGS ESTABLISH UNUSUAL BEARING RECORD

▲ An unusual record of service for anti-friction bearing equipment has been revealed by SKF Industries, Inc., for the first spherical roller bearings ever used by American industry.

Now widely applied to heavy equipment in all industries, the spherical roller bearing was introduced in 1921 by the Philadelphia ball and roller bearing company with installations on six Pennsylvania Railroad passenger cars. All of the bearings were designed for high load capacity and long life.

Of the 52 original bearings, 17 still were in operation, all with 2,400,000 miles or more of service, when the railroad removed them recently because of obsolescence of the truck assemblies.

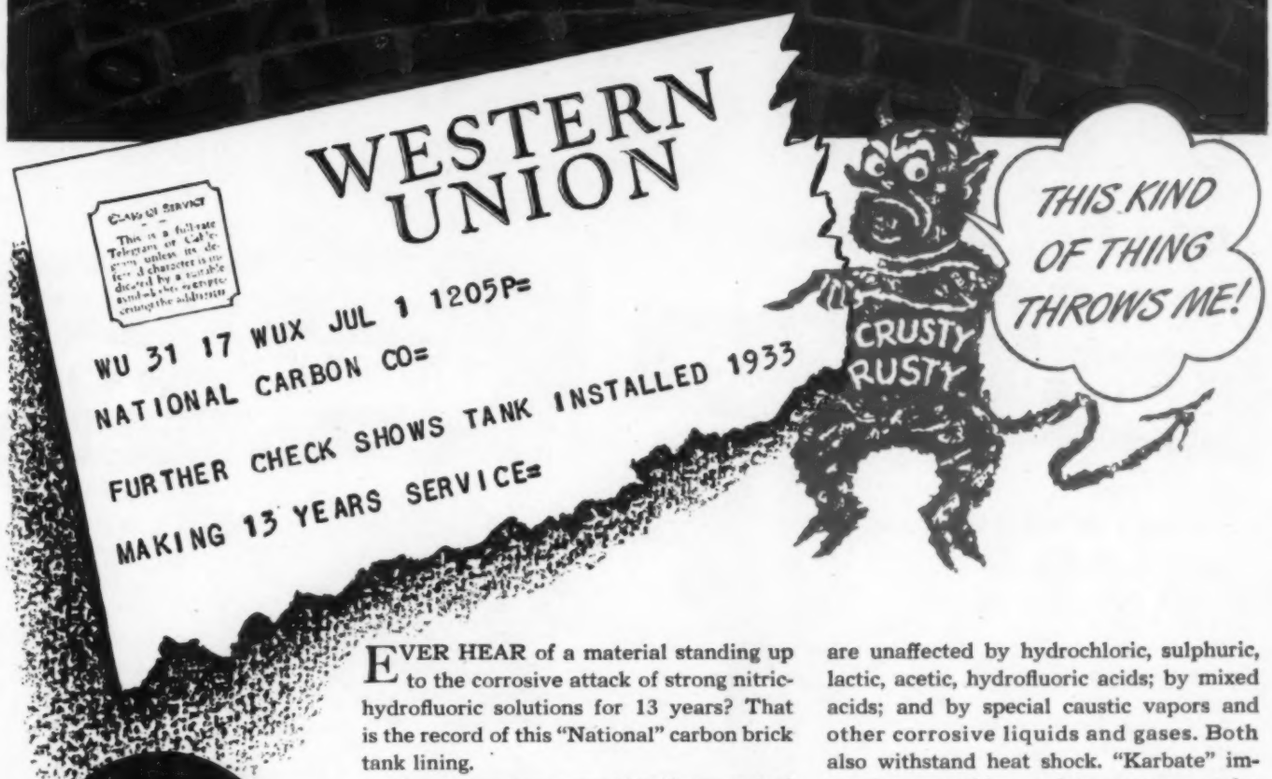
—12-E-15—

ELECTRIC FOOT CONTROL LOWERS OPERATOR FATIGUE

▲ Control of "Steelweld" shears built by the Cleveland Crane and Engineering Company, has been made extremely easy and convenient by a new type electric foot control which has

13 YEARS IN NITRIC-HYDROFLUORIC SOLUTIONS!

Yet— THIS CARBON TANK LINING IS STILL IN GOOD OPERATING CONDITION!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FURTHER CHECK SHOWS TANK INSTALLED 1933
MAKING 13 YEARS SERVICE=
CRUSTY RUSTY
THIS KIND OF THING THROWS ME!

WHATEVER YOUR PROBLEM —CONSIDER CARBON OR GRAPHITE

EVER HEAR of a material standing up to the corrosive attack of strong nitric-hydrofluoric solutions for 13 years? That is the record of this "National" carbon brick tank lining.

Yes, carbon has proved itself unmatched for lining acid-bearing tanks and towers. Equally useful for building these tanks and towers, with or without supporting walls, is "Karbate" impervious graphite.

These two lightweight, inert materials are unaffected by hydrochloric, sulphuric, lactic, acetic, hydrofluoric acids; by mixed acids; and by special caustic vapors and other corrosive liquids and gases. Both also withstand heat shock. "Karbate" impervious graphite resists seepage under pressure and is mechanically strong.

Both materials are available in brick and blocks, in standard and special shapes. For more details on how these materials can be useful in your plant, write Dept. I. S.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

UCC

30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

been adopted as a standard feature on all size machines.

A safety type switch, connected to an outlet at front of the machine by a heavy cable, controls the movement of the blade. The switch can be slid around the floor to wherever most convenient to use. When shearing is done on a continuous production basis, the foot switch reduces the fatigue of the operator considerably. The foot switch requires only a slight movement of the toe, whereas with the usual mechanical foot treadle the entire leg must be raised several inches for each cut.

The electric control is especially advantageous when cutting long sheets necessitating the operator being several feet from front of the machine. For instance, when cutting quantities of narrow strips from long sheets of metal, the operator can push the sheet at the end and slide the switch along the floor as the sheet becomes shorter. Because of the ease and convenience of the foot control, production can be increased materially.

—12-E-16—

FORK TRUCK ELEVATES 18 FT ABOVE FLOOR LEVEL

▲ A new fork-type power industrial truck with an elevating reach of 18 feet above floor level is announced by Elwell-Parker Electric Company. Standard models heretofore have had a lifting range up to 10 or 12 feet, a few special models going as high as 16 feet.

New features of design and construction make the truck especially useful for high-tiering materials and merchandise. It is unusually compact, with increased speed and flexibility for maneuvering, and lifting and lowering loads.

The new truck picks up loads on its bare fork or on pallets in the same manner as with standard models. Its capacity is rated at 4000 pounds for lifting to a height of 11 feet, and 3000 pounds to 18 feet. It is electrically driven, with three separate motors; one for traveling, one for operating the elevating mechanism, and the third for tilting the upright columns. Tilting limit is 15 degrees backward and 5 degrees forward from vertical.

Lifting speed with capacity load is 13 feet per minute, lowering speed 20 feet per minute; truck's traveling speed 5 miles an hour.

—12-E-17—

RYERSON CONSTRUCTING WEST COAST WAREHOUSE

▲ Announced as the largest individual project in their extensive postwar expansion and plant modernization program, Joseph T. Ryerson and Son, Inc., the country's largest distributor of steel from warehouse stocks, revealed details of the construction that is well under way on their new steel-service plant on the west coast.

Located in the central manufacturing district, southeast of the city of Los Angeles, this new unit, the twelfth in the Ryerson nation-wide system, will be one of the largest and best equipped steel-service plants in the entire west coast area.

FOR A GROUP OF OIL BURNERS OF SMALL CAPACITY

BLOOM UNIT ATOMIZER

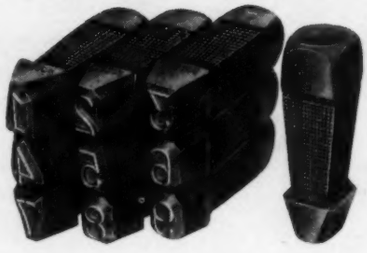
Provides a Method of Burning Small Quantities of Heavy Fuel Oil at Each Burner

The atomizer operates on high pressure steam. It atomizes a reasonable quantity of oil and then divides and distributes this quantity into equal parts, which are delivered to a number of small burners.

An easy system to control. A workable method for a combination oil/gas application to small gas burners. Suitable for oil application to burners requiring 1½ to 3 g.p.h.

BLOOM ENGINEERING CO.
857 W. North Avenue Pittsburgh 12, Pa.

Help prevent an accident today!
CUNNINGHAM
SAFETY (Reg. Trade Mark) Wedge Grip
LETTERS and FIGURES



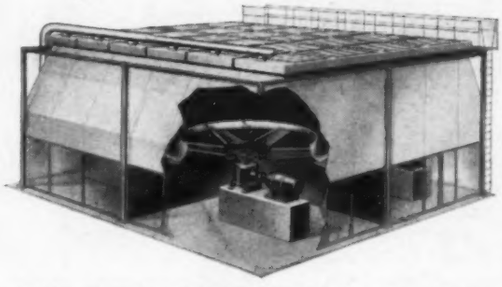
- No mushroom
- No spall
- 25% to 50% more service
- More Safety!
- Pat. No. 2,089,794

Perfect balance . . . Knurled sides not only assure *positive* grip with "Wedge Grip" to give clearer, deeper impressions—but also lessen severity of extra heavy stamping. Characters available from 1/16" to 1".

Have you the new Cunningham Safety Marking Tool folder?

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
105 EAST CARSON ST., PITTSBURGH 19, PA.

FIN·FAN ON A ROOF SAVES SPACE AND DOES A 3-WAY JOB



FLUOR FIN·FAN COOLING UNIT consists of finned tubes over which air is circulated by variable pitch fans. FLUOR also builds Aerator and Counterflow Cooling Towers. Thus, FLUOR recommendations are based on the type of unit best suited to the specific job.

Ground space in the heart of New York City is expensive . . . as it is most everywhere these days. The FIN·FAN Cooling Unit shown above requires no ground space because it is installed on the roof. Its K-Fin tube sections are cooled by air, so it saves water, too.

This FLUOR FIN·FAN Cooling Unit cools and condenses 2760 lbs. per hour of ammonia, affording 105 tons of refrigeration. It also cools 261 g.p.m. of jacket water from 140° to 130°F. And, at the same time, it cools a separate stream of 40 g.p.m. of lube oil cooling water from 106° to 95°F. TRIPLE duty from a SINGLE unit!

During winter months, when air temperatures are lower, the variable pitch fan blades can be adjusted to reduce power consumption, thus effecting more economical operation.

The FLUOR FIN·FAN Cooling Unit is adaptable to all kinds of cooling and condensing services involving pressures to 5,000 p.s.i. and temperatures to 1,500°F. Write for Engineering Data.

BE SURE SINCE 1890 WITH FLUOR

FIN·FAN Cooling Units are manufactured and sold by: The Griscom-Russell Co. and The Fluor Corporation, Ltd.

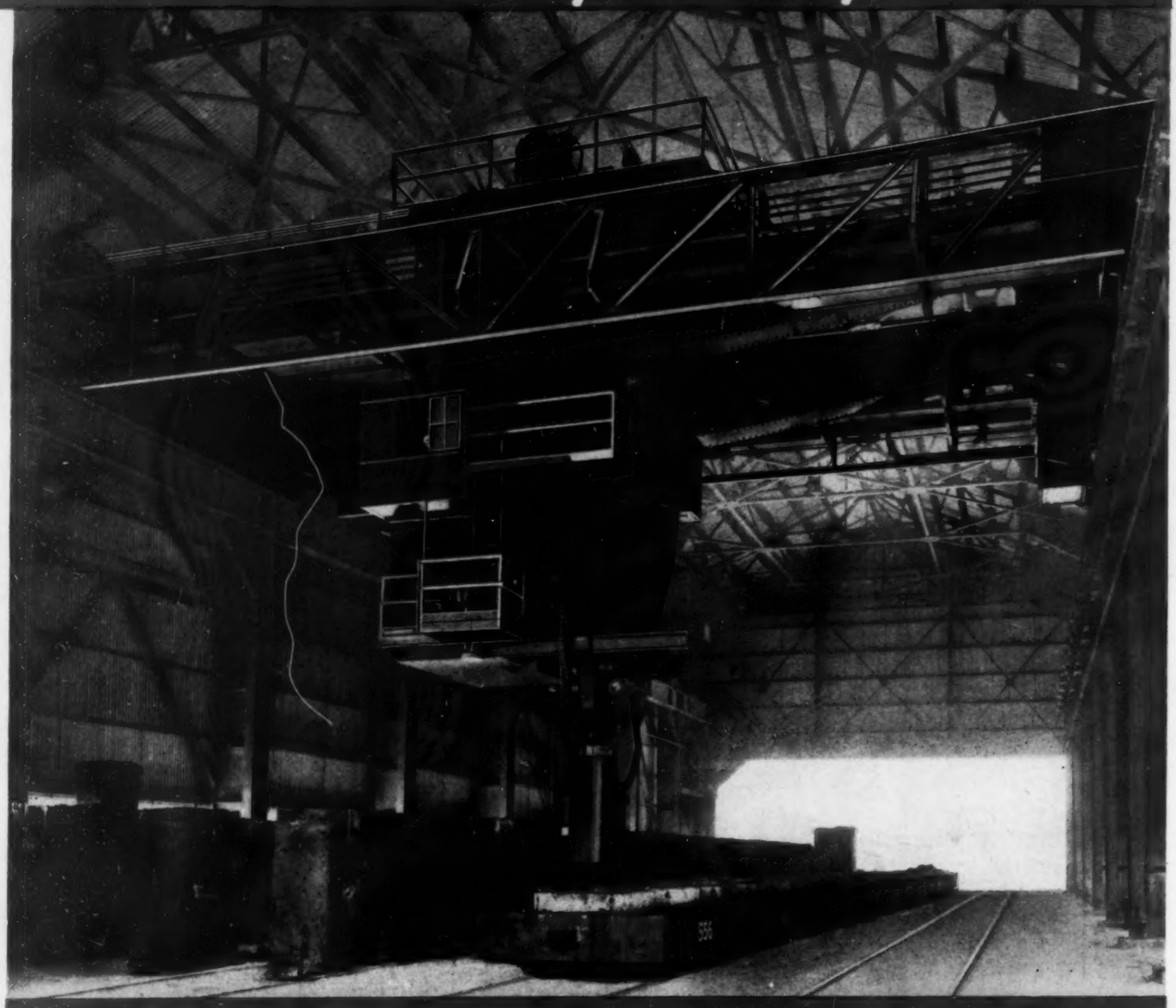
FLUOR FIN·FAN COOLING UNIT

THE FLUOR CORPORATION, LTD., 2500 South Atlantic Boulevard, Los Angeles 22

NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA • BOSTON

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

BUILT BY MORGAN *Engineering*



ONE OF TWO MORGAN 200-TON, 63'0" SPAN UNIVERSAL TYPE INGOT STRIPPERS IN A MID-WESTERN ELECTRIC FURNACE STEEL PLANT

The Stripper as illustrated will perform three distinct stripping operations without change in the stripping unit.

(1) Strip small-end-up or standard ingots.
(2) Strip big-end-up hot top ingots.
(3) Break small-end-up ingots loose from stools.

With this type of Stripper it is possible to strip a mixed heat without lost time.

Additional Morgan equipment in this plant includes: Two 300-Ton, 65'0" Span Pouring Cranes. Three 150-Ton, 65'0" Span Pouring Cranes. Two 150-Ton, 80'3" Span Hot Metal Charging Cranes.

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ALLIANCE, OHIO. 1439 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Personnel News . . . .

A. S. Glossbrenner has been elected by directors of The Youngstown Sheet and Tube Company as assistant vice president in charge of steel operations, under **J. L. Mauthe,** vice president in charge of operations, effective January 1, 1947.

Mr. Glossbrenner has been general superintendent of Youngstown district manufacturing properties for more than three years. Mr. Glossbrenner has been secretary of the AISE during 1946, and will act as treasurer in 1947.

H. E. Englebaugh, assistant general superintendent of Youngstown manufacturing properties, will become manager of Youngstown district operations, effective January 1.

Richard C. Gerdes was appointed Chicago district supervisor of production planning for American Steel and Wire Company, succeeding **J. A. Robinson** who retires after 46 years of continuous service. Mr. Gerdes advances to his new post from the company's Joliet works, where he has served as works supervisor of production planning for the last three years. He began his association with the American Steel and Wire Company in 1929 in the office of the manager of operations, Chicago district.

A. F. Franz was elected vice president in charge of operations, Colorado Fuel and Iron Corporation, Pueblo, Colorado. He will succeed **Robert T. Dunlap** of Buffalo, New York, who has resigned.

Mr. Franz is a native of Cleveland, Ohio. Before coming to the Wickwire Spencer Steel division at Buffalo, New York, as general superintendent of the Buffalo plant, he was associated with the Alan Wood Steel Company, Conshohocken, Pennsylvania. Mr. Franz was appointed works manager of the Colorado division in March, 1946. In his new position he will have complete charge of all operations of the corporation.

William K. Bonte has been appointed chief industrial engineer of Republic Steel Corporation, in an announcement by **E. M. Richards,** vice president in charge of operations. Mr. Bonte succeeds the late **Elmer Kropp,** who died November 16th after a prolonged illness. Mr. Bonte has been acting chief industrial engineer for the past 10 months.

Mr. Bonte was born in 1891 in Reading, Pennsylvania, and studied at the Wharton School of Finance of the University of Pennsylvania in Philadelphia. His first employment in the steel industry was with Carpenter Steel Company in Reading, Pennsylvania, and he later worked for Peerless Drawn Steel Company, Massillon, Ohio, (now a part of Republic Steel's Union Drawn Steel Division) and with Bethlehem Steel Company in Bethlehem, Pennsylvania.

During the past 25 years he has been associated with Central Steel Company and Republic Steel Corporation with which Central Steel was merged in 1930, in supervisory capacities principally in the accounting department. From 1931 to 1936 he was works accountant for the Youngstown and Warren districts. In 1936 Mr. Bonte was transferred to the staff of the comptroller of Republic Steel Corporation and was responsible for works accounting and inventories.

His extensive experience in cost reduction, together with his knowledge of steel plant operations, led to his present position in the industrial engineering department when illness forced Mr. Kropp to become inactive.

Dr. C. Earl Webb of Chicago has been appointed chief engineer, American Bridge Company. He succeeds **Dr. Charles F. Goodrich,** who is retiring after 40 years service with this United States Steel subsidiary. Succeeding Dr. Webb as the company's western division engineer is **Albert P. Boysen,** who has been associated with American Bridge since 1912.

Dr. Webb is a native of Mason, Michigan, and a graduate of Michigan State college, which in 1940 awarded him with an honorary degree of doctor of engineering. He began his association with American Bridge in 1914 as a draftsman in the plant at Gary, Indiana. In 1922 he became designing engineer at the company's Chicago office and served in this position until his appointment in 1935 as western division engineer in Chicago.

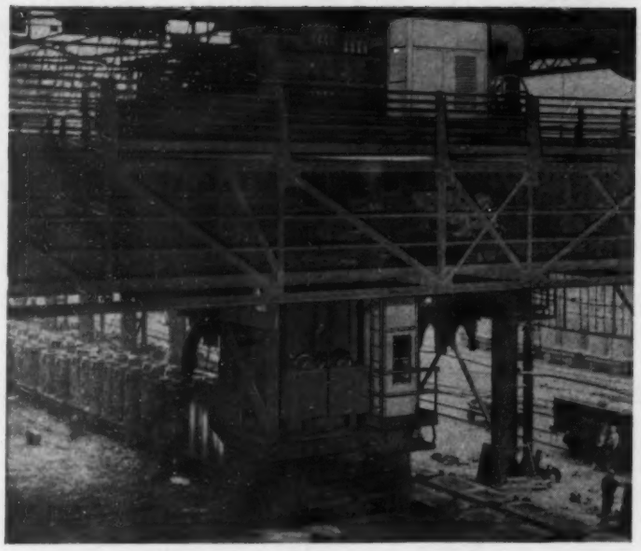
Mr. Boysen received his technical education in the Chicago Technical college and Armour Institute of Technology. He started with American Bridge as a shop clerk and later became a draftsman. Since 1942 he has been in charge of design for important United States Steel building activities in the western district,

A. S. GLOSSBRENNER

H. E. ENGLEBAUGH

WILLIAM K. BONTE

DR. C. EARL WEBB



Soaking Pit Crane in plant of a prominent steel company, equipped with Lintern Aire-Rectifier 145 AC-24.

Soaking Pit Crane Cabs Successfully Air Conditioned with Lintern Aire-Rectifiers

● "Air condition a soaking pit crane cab and you can air condition any of 'em," said the mill superintendent. We did it.

And we have done it with units which have demonstrated over the months and years their *low maintenance*. In a large number of plants Lintern Aire-Rectifiers, *with air-cooled condensers*, have performed successfully under the most severe conditions.

Lintern *balanced refrigeration design* prevents overloads in temperature as high as 170° F. This is the only crane cab conditioner which has had thorough testing on soaking pit applications. *It is tried and proved.* Only periodic inspection is required.

Ask for Bulletin AC 11546.

THE LINTERN CORPORATION

54 LINCOLN AVENUE - - **BEREA, OHIO**

Aire-Rectifiers, Ventilating Heaters, Glowlites, Crane Safety Equipment, Safety Signals and Markers.

including the design of structural steel for the corporation's newest subsidiary, the Geneva Steel company plant at Geneva, Utah.

Leonard W. Bughman was elected president of the Edgar E. Brosius Company, Inc., Pittsburgh, Pennsylvania. Mr. Bughman attended the Choate Preparatory School at Wallingford, Connecticut and then spent a year studying at the Sorbonne in Paris, France. After his return to this country he attended the University of Pittsburgh. His entire business career has been spent at the Mellon National Bank of Pittsburgh.

LEONARD W. BUGHMAN

J. E. Sullivan will be vice president in charge of sales for Edgar E. Brosius Company, Inc., Pittsburgh, Pennsylvania. Mr. Sullivan is a graduate of Pennsylvania State College, class of 1910. Upon graduation he was employed by the Carnegie-Illinois Steel Company at their Ohio works, Youngstown, Ohio. In 1912 he was appointed assistant superintendent of blast furnaces of the Maryland Steel Company at Sparrows Point, Maryland. When the Bethlehem Steel Company acquired the Sparrows Point works in 1916, he was made superintendent of blast furnaces and ore docks, which position he held until 1927, at which time he accepted the position of vice president and sales manager for Edgar E. Brosius Company, Inc., of Pittsburgh. He has held this position until the present time and will continue as vice president in charge of sales for the new corporation.

J. H. Davis is secretary and treasurer of Edgar E. Brosius Company, Inc., Pittsburgh, Pennsylvania. Mr. Davis, a graduate of Carnegie Institute of Technology, started as a private secretary to Lorenz Iversen of the Mesta Machine Company. Later he worked under Professor Willibald Trinks of the Carnegie Institute of Technology, also in a secretarial capacity. In 1917 he became associated with Mr. Edgar E. Brosius and has been in his employ as office manager and treasurer until Mr. Brosius' retirement.

David S. Holbrook has been elected vice president of Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada. He came to Algoma in 1944 as assistant general manager and in 1945 was appointed executive assistant to the president.

Graduating from the University of Pittsburgh engineering school in 1932, Mr. Holbrook entered the steel

It takes all seven..

to permit you to select the Insulating Fire Brick with the correct *balance* of thermal and physical properties for each service in your plant.

PROPERTIES	INSULATING BRICK			INSULATING FIRE BRICK AND FIREBLOK			
	Sil-O-Cel Natural	Sil-O-Cel C-22	Sil-O-Cel Super	JM-1620	JM-20	JM-23	JM-26
Density—lb. per cu. ft.	30	38	40	29	35	42	48
Transverse Strength—lb. per sq. in.	140	115	90	60	80	120	125
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	115	170	190
Linear Shrinkage—Percent	1.4 @ 1600F	0.8 @ 2000F	2.0 @ 2500F	0.0 @ 2000F	0.0 @ 2000F	0.3 @ 2300F	1.0 @ 2600F
Reversible Thermal Expansion—Percent	0.1 @ 1600F	0.7 @ 2000F	1.3 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F
Conductivity at Mean Temperature	∥ ⊥						
500F	1.01 .67	1.67	1.70	.77	.97	1.51	1.92
1000F	1.13 .79	1.88	1.95	1.02	1.22	1.91	2.22
1500F	1.24 .90	2.08	2.19	1.27	1.47	2.31	2.52
2000F	— —	—	2.45	—	1.72	2.70	2.82
Recommended Service							
Back Up	1600F	2000F	2500F	2000F	2000F	2300F	2600F
Exposed	—	—	—	1600F	2000F	2300F	2600F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note: 1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu in. per hr per sq ft per deg F at the designated mean temperatures.
3. ∥ —with heat flow parallel to brick strata.
⊥ —with heat flow perpendicular to brick strata.

No one brick can perform properly under all steel mill service conditions. That's why Johns-Manville makes seven types of Insulating Brick and Insulating Fire Brick. Each is designed for a specific job . . . and *engineered* to do its job with maximum efficiency.

The three J-M Insulating Brick provide great structural strength; the four J-M Insulating Fire Brick combine strength with exceptional resistance to spalling. All offer the advantages of light weight and low conductivity. They are recommended as back-up insulation or insulating fire brick for all industrial requirements.

For complete details, write Johns-Manville, Box 290, New York 16, N.Y.

JOHNS-MANVILLE *First in* INSULATIONS

LUBRICATION COSTS GO

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WITH

NON-FLUID OIL

TRADE MARK REGISTERED

● When your machines are stopped does your present lubricant drain away?

When your machines are operating does your lubricant seek and remain at the point of friction?

Your lubricating costs will go down with NON-FLUID OIL because it "stays put" until entirely used up and does not drain away from bearings when machinery is stopped. NON-FLUID OIL also eliminates costly spoilage loss of goods because it avoids the dripping and slinging of oil—providing positive lubrication upon split-second demand.

Write today for your copy of our latest bulletin on lubrication of textile machinery.

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292 MADISON AVENUE, NEW YORK 17, N Y

industry with the Carnegie-Illinois Steel Corporation at Youngstown where he held various engineering and operating positions until 1940 when he was transferred to the Homestead district of Carnegie-Illinois Steel Corporation. As assistant chief engineer he was associated with much of the wartime expansion at Homestead, and was in charge of engineering and construction of the new defense plant there.

JOHN P. ROCHE recently named vice president and general manager of sales for Heppenstall Company, Pittsburgh, Pennsylvania. Announcement of this appointment appeared on page 136 of the *IRON AND STEEL ENGINEER*, November 1946.

H. M. Dawson has been appointed managing director of Jessop Steel International Corporation, wholly owned subsidiary of Jessop Steel Company, Washington, Pennsylvania. Mr. Dawson's headquarters are in the Evening Post Building, 75 West Street, New York City.

Harry W. Bearfoot was appointed representative for Kennametal, Inc., in the Baltimore area. This area is part of Kennametal's Middle-Atlantic district, the headquarters of which is at 3701 North Broad Street, Philadelphia, Pennsylvania.

Elmer Anderson, formerly service engineer in the Milwaukee office of the Timken Roller Bearing Company, has been appointed assistant service manager of the Canton, Ohio, office.

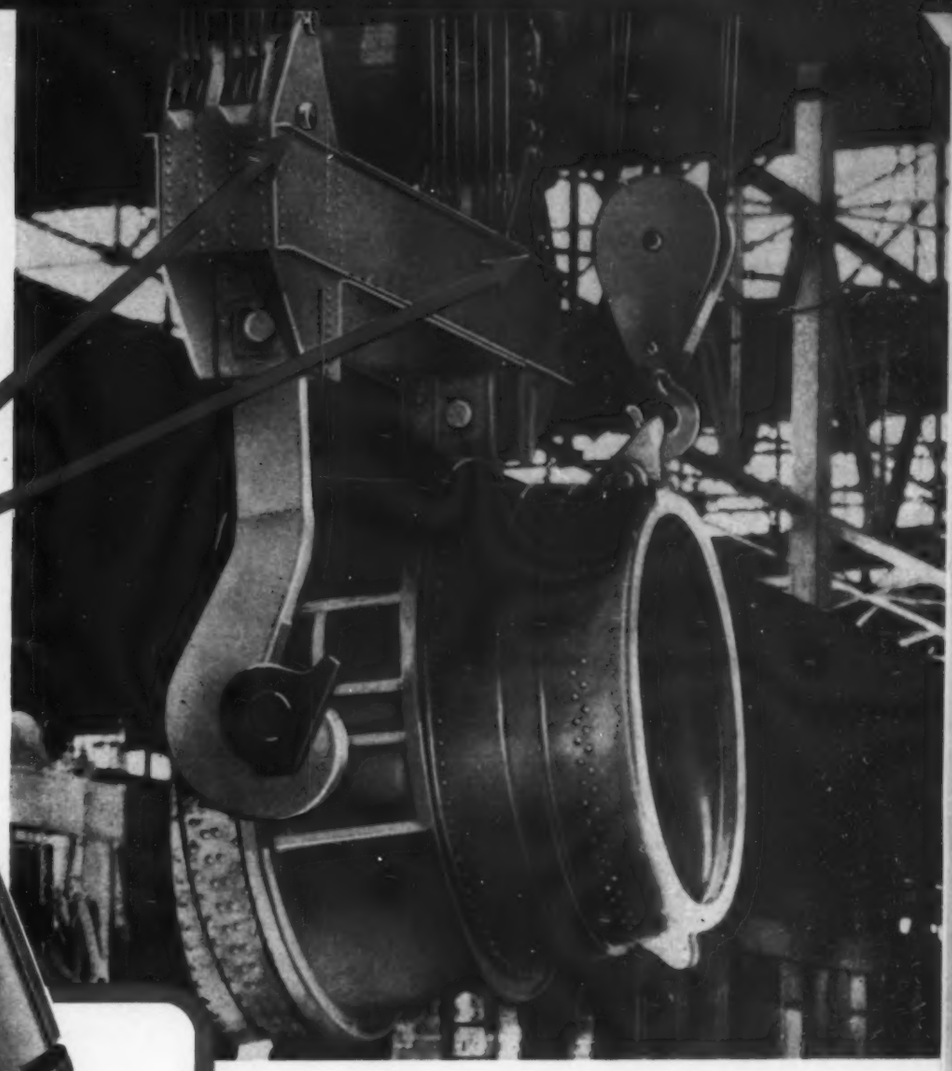
Graduated from the University of Wisconsin in 1929 with a bachelor of science degree, Mr. Anderson joined the engineering staff of the Timken company in February, 1929. From that post, he went to Milwaukee, where he has been service engineer since 1933.

Theodore S. See has been appointed first vice-president and general manager of La Salle Steel Company, Chicago 80, Illinois.

Howard J. Jones was appointed manager of industrial relations, for the Colorado Fuel and Iron Corporation, Denver, Colorado. For the past twelve years Mr. Jones was associated with the Republic Steel Corporation in a similar capacity. He will head a progressive program of industrial relations.

Horace J. Jones was appointed manager of industrial engineering for the Colorado Fuel and Iron Corporation, Denver, Colorado. His comprehensive knowledge of this highly important work was gained through twenty-nine years of practical experience with his former connection, the Republic Steel Corporation.

"TOOL STEEL" PROCESS
SHEAVE
PIN



"Bushed" BUSHINGS are few and far between with "TOOL STEEL" PROCESS sheave pins

Product . . . . "Tool Steel" process sheave pins in service on hot metal mixer cranes as shown above.

Plant . . . . . In use by one of the world's largest steel companies. Name on request.

Service Record installed June 27, 1941 and replaced October 14, 1946, after handling 3,535,198 tons. During this period sheave wheels and bushings were changed only twice!

Comments . . . "Tool Steel" pins showed a tonnage superiority of 13 to 1 over ordinary heat-treated pins which were used previously. Competitive pins lasted five months, completely wore out their bushings, and handled only 272,614 tons! This is another example of "Tool Steel's" superiority!

Changing bushings is an expensive, time-consuming operation, but there is something you can do about it!

Specify "Tool Steel" sheave pins and your maintenance is materially and immediately reduced.

Here's why! The surface of "Tool Steel" pins tests from 85 to 90 scleroscope (635-700 Brinell), deep enough for the life of the pins. This guarantees a true surface even under the most severe operating conditions and prevents unnecessary wear on bushings.

The costs are comparable to ordinary pins, but your savings with "Tool Steel" are substantial. Write today for complete information.

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO

CARL A. ILGENFRITZ

J. P. SIMON

GILBERT SOLER

RUDOLPH T. ELSTAD

Charles R. Miller, Jr., vice president, purchases, United States Steel Corporation of Delaware retired December 1, 1946, after 49 years of continuous service with United States Steel subsidiaries.

First entering the employ of the Carnegie Steel Company as an office boy in 1897, Mr. Miller subsequently served as order clerk, bill clerk, and chief clerk in the purchasing department until 1918, when he was promoted to purchasing agent of that company.

When Carnegie-Illinois Steel Corporation was formed in 1935, he became purchasing agent for the Pittsburgh district, and in 1940 was appointed director of purchases, United States Steel Corporation of Delaware. He was elected vice president, purchases, on January 1, 1942.

Carl A. Ilgenfritz was elected vice president, purchases, United States Steel Corporation, succeeding **Charles R. Miller, Jr.,** who has retired. Since September 1945, Mr. Ilgenfritz has been vice president in charge of purchases, Carnegie-Illinois Steel Corporation.

A native of Youngstown, Mr. Ilgenfritz began his business career as a storekeeper with the Youngstown Sheet and Tube Company, later serving in the mechanical department of the company. In 1913 he joined the engineering department of Brier Hill Steel Company, becoming assistant purchasing agent in 1917, and purchasing agent a year later.

Subsequently he organized the Stroh-Ilgenfritz Company, Youngstown, Ohio, dealers in coal, coke, pig iron and alloys, now the Stroh-Butler Company. Resigning as vice president of this concern in 1924, he became assistant purchasing agent for Youngstown Sheet and Tube Company.

He was named general purchasing agent for the United Alloy Steel Corporation at Canton in 1925, and in the following year became director of purchases for Central Alloy Steel Corporation, Massillon. When Republic Steel Corporation was organized in 1930 by the merger of Republic Iron and Steel Company, Central Alloy Steel Corporation and other producers, he became director of purchases of Republic and in 1933 was made manager of purchases and raw materials.

J. P. Simon was appointed manager of the Cutler-Hammer, Inc. Philadelphia district office. In this position, Mr. Simon will have direct charge of all sales in the Philadelphia territory and will have supervision of the company's branch offices in Baltimore, Maryland, Washington, D. C., and York, Pennsylvania.

Gilbert Soler has been appointed general superintendent, Atlas Steels Ltd., Welland, Ontario, Canada. Mr. Soler had been assistant general superintendent, steel division, Timken Roller Bearing Company, Canton, Ohio. He joined Timken in 1931. Prior to that, he was a research engineer, Republic Steel Corporation, Cleveland, Ohio. **A. C. Texter** has been appointed assistant general superintendent for Atlas Steels Ltd. Mr. Texter had been melting superintendent for the firm since 1931. Before joining Atlas, he was assistant melting superintendent, Park works, Crucible Steel Company of America, Pittsburgh, Pennsylvania.

H. M. Griffith has been promoted from the position of assistant works manager to general superintendent, Hamilton and Ontario Works of the Steel Company of Canada, Limited.

G. P. McAleer has been appointed assistant general superintendent. Mr. McAleer was formerly at the Gary plant of the Carnegie-Illinois Steel Corporation.

Rudolph T. Elstad was elected president of the Oliver Iron Mining Company, of Duluth, Minnesota, a United States Steel subsidiary. Mr. Elstad succeeds **LeRoy Salsich,** who is retiring after forty-five years of operating and executive experience with the Oliver company. **Walter L. Maxson,** director of research, and **Jerome E. Machamer,** assistant general superintendent of the Hibbing-Chisholm district, have been elected vice presidents of the Oliver company.

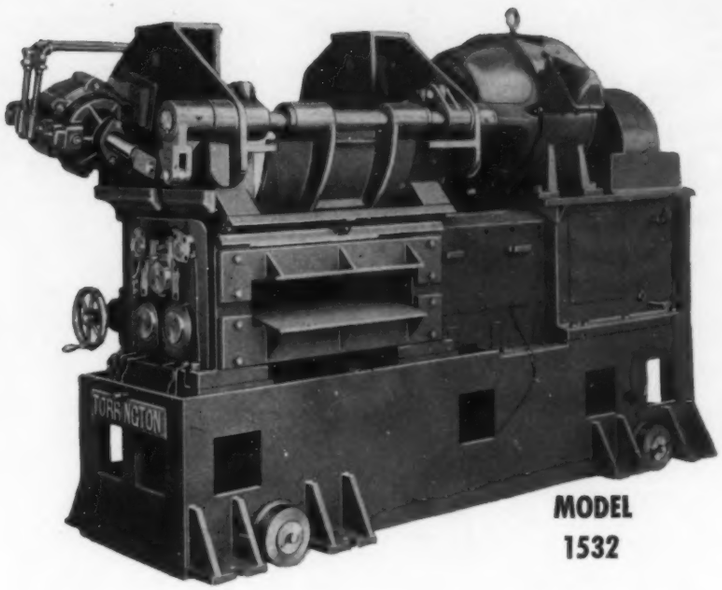
Mr. Elstad began his service with the Oliver company during his summer vacations in 1917 and 1918 and joined its organization after graduating from the University of Minnesota with the degree of bachelor of science in civil engineering in 1919. He was elected vice president on January 1, 1946.

Mr. Salsich graduated at the University of Wisconsin with the degree of civil engineer in 1901 and joined the Oliver company as a mining engineer at the time of the mining company's formation in that year. A year later he became chief engineer for the Hibbing properties. He became president on March 1, 1930, as a successor to **Pentecost Mitchell.**

Mr. Maxson, a graduate of Cornell, has followed the mining profession for thirty years. He was selected as the director of a large research laboratory established by United States Steel under the auspices of the Oliver company in 1944.

Mr. Machamer joined the Oliver organization in 1922 as a mining engineer and has held many posts with the company since then.

Another TORRINGTON *Special*



MODEL
1532

ROLL COILING MACHINES

Roll Coiling Machines coil strip metal to conserve space and are usually used when the gauge is too thick to spool-wind or when the coil need not be tightly wound as is possible with a reel or winder. A coiling machine, unlike a reel, is automatic and safer for the operator.

MODEL 1532 is one of 9 coiler models made by The Torrington Manufacturing Company. Three models (459, 993, 335) are 2 housing coilers without feed rolls which coil metal in gauges from .040″ to .250″ in widths of 12″ to 24″. Of the 4 housing coilers, models 1415 and 1532 have no feed rolls and handle gauges from .072″ to .375″ in widths of 12″ to 48″. Models 1649, 1661, 1117 and 1696 have feed rolls and handle gauges from .065″ to .500″ in widths of 12″ to 48″. The four housing models are designed for use with wide sheets or at high speeds. This design eliminates distortion of the pinions when deflection of the rolls occurs. The separately housed pinions run in lubricant which assures long gear life and low maintenance costs. All of these standard designs can be readily modified to meet special requirements.

Roll Coilers are only one of the many special machines for processing sheet, strip, flat wire, rods and tubes that Torrington has been designing and building for over 60 years. All standard designs can be easily modified to meet special requirements. Our highly trained design and engineering staff and all the facilities of an extensively equipped, modern plant are at your service.

Privacy is guaranteed when we work with or under the supervision of customers. All materials and workmanship are guaranteed.

Call or write Torrington Manufacturing with complete details of your requirements. We'll build a machine to suit *your* specifications and will also help set it up and start it in production.

The **TORRINGTON**
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT

New Members

Active

ARTURO ACEVEDO
Vocational Training
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CLIFFORD C. DECK
Assistant to Superintendent Central Mills
Carnegie-Illinois Steel Corporation
Gary, Indiana

WALTER DRIVER
Manager, Sheet Mill Division
South African Iron and Steel Industries Corporation, Ltd.
Pretoria, South Africa

JOHN DOUGAN
Assistant Roll Designer — Chief Template Maker
Colvilles, Ltd.
Glengarnock, Ayrshire, Scotland

S. O. EVANS
Electrical Engineer
Babcock & Wilcox Tube Company
Beaver Falls, Pennsylvania

J. ROBERT FERGUSON, JR.
Assistant to Chief Engineer South Works
Carnegie-Illinois Steel Corporation
Chicago, Illinois

CHARLES M. FITZPATRICK
Assistant Superintendent Blooming Mills
Bethlehem Steel Company
Sparrows Point, Maryland

KENNETH FOSTER
Roller
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

W. M. FRAME
Works Manager — Ambridge Plant
Spang-Chalfant Division
National Supply Company
Ambridge, Pennsylvania

ROBERT GUTHRIE
Metallurgical Engineer
Strip and Sheet
Ford Motor Company
Dearborn, Michigan

ELMER N. HULL
Engineer
Ford Motor Company
Dearborn, Michigan

J. C. KERRIGAN
Turn Foreman By-Product and Benzol
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

JOHN B. KURTZ
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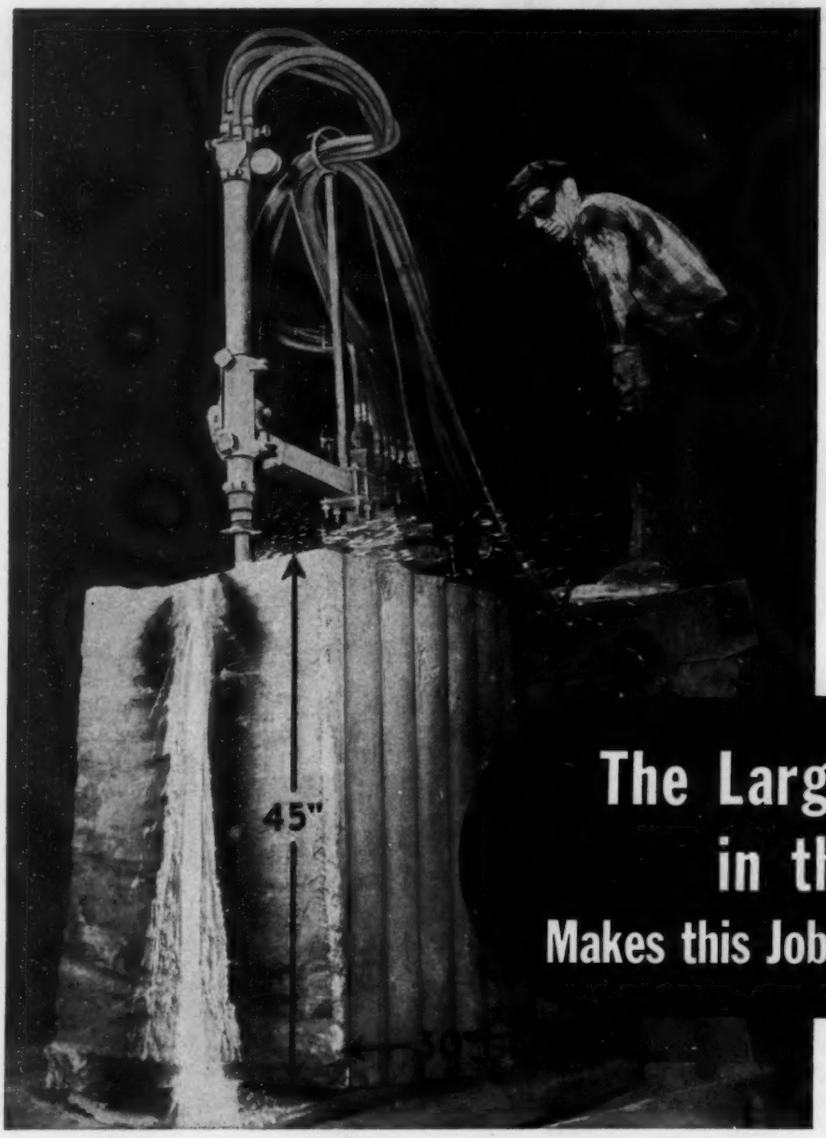

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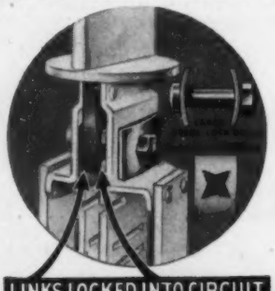

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